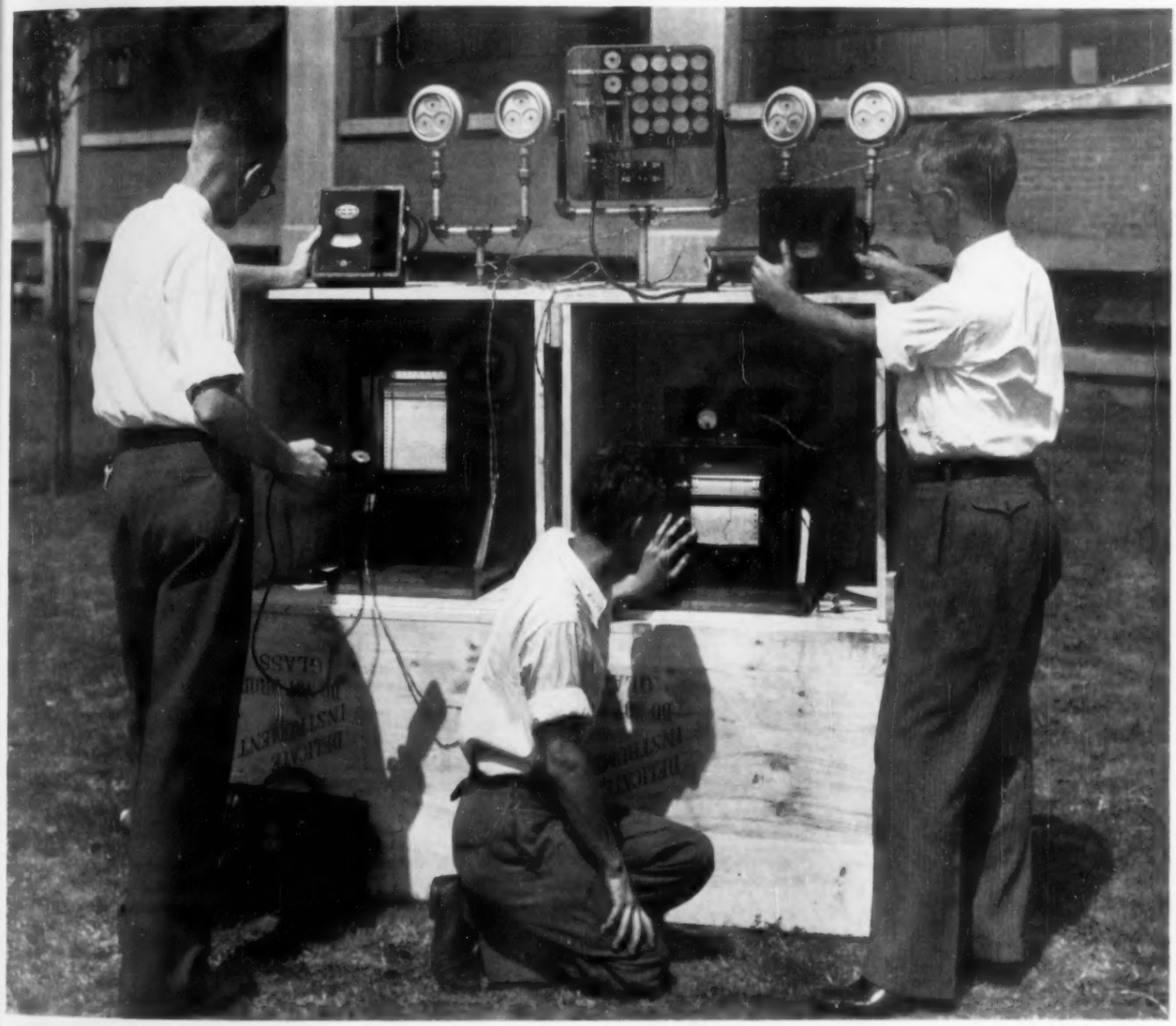
INSTRUMENTS

THE MAGAZINE OF MEASUREMENT AND CONTROL

VOLUME 5 SEPTEMBER, 1932 NUMBER 9



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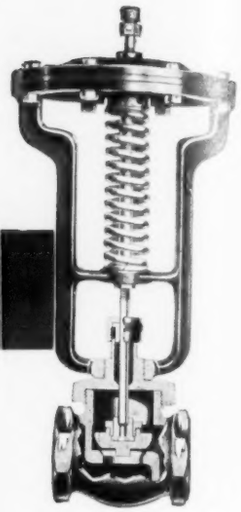

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EDITORIAL COMMENT

In This Issue

Let us, this month, try the experiment of starting from the back. The reason is that the

◆ **Current Literature Review** is unusually long and diversified. Under each classification each reader will probably find abstracts of immediate interest to him.

◆ **New Instruments** for many purposes, both old and new are announced by a number of firms that are helping to end the depression by mixing inventive brains with courageous activities.

◆ An unusually large number of **Book Reviews** meets the eye and some of the titles will hold your attention.

◆ In his monthly installment **Béhar** takes up those so-often overlooked instruments, the **Current Meters** which—judging from his little drawings—find uses in many different fields.

◆ **Professor de Juhasz** continues his extraordinarily detailed study of **Engine Indicators** and his lucid descriptions of drums, pulleys and other parts should delight all lovers of fine mechanisms.

◆ **Instruments Help to Build and Sustain a New Industry.** Little can we say, with such a catchy title. **W. A. Cotton, Jr.** gives due credit to Instrumentation for the birth and growth of the Masonite Corp.

◆ ◆ ◆

The Front Cover

—shows equipment developed by the Weston Electrical Instrument Corp. for measuring illumination variations throughout the solar eclipse of August 31st. These instruments were used by scientists at Magog, Canada.

Not for Sale

WHEN you look through the automobile news section of your favorite Sunday paper, you no doubt accept the illustrated items on the new models for what they are—news. Unless, of course, your paper is one of the few that still run those sickeningly sugary puffs to please their advertisers, and omit legitimate news of non-advertisers' activities—in which case you take little stock in the contents of its automobile section.

Among technical periodicals are some professional association journals carrying no equipment news at all; also—at the "extreme left"—papers made up almost entirely of news and advertisements, utterly lacking original articles and padded out with personals, poetry and piffle. Between these two groups come the majority—publications setting before their subscribers a more or less properly balanced diet of reading matter. A few have won the right to be called magazines—only a few, for the standard is hard to attain and hard to maintain. The difficulties, needless to explain in detail, are labeled with the dollar sign. That is why most technical periodicals are just trade papers. Few trade paper founders even intend to present news impartially: from the start they take the easy road of shutting their columns to all news made by research and manufacturing organizations whose only sin consists of having advertising appropriations and not advertising in their papers!

Some trade paper publishers camouflage or try to justify this sordid policy by declaring that they oppose "free advertising." To such a publisher the long-sought solution of a problem that faces his industry is not news if that solution sprang from the brains of engineers, physicists and chemists on the staff of a non-advertiser.

In other words, these publishers sell their editorial pages. They cannot have their readers' interest at heart, and in fact they don't. Pay them their thirty pieces and they will print anything you want, dressed up as "news."

INSTRUMENTS is the *Magazine* of measurement and control. Its news pages are not for sale.

Make no mistake about it: the New Instruments department is not controlled by advertisers but is conducted solely for the information of our readers.

Not one single item of legitimate news interest to our readers has ever been "killed." We not only accept and print real news but our modest yet fairly far-flung organization *hunts* high and low for news of instrument developments. This policy being exceptional, some manufacturers, when they give descriptions and photographs to our representatives, actually apologize for "troubling" a magazine in which they do not advertise. As if their appropriations could buy a single inch of our news space!

In line with this policy, any matter received and deemed, after examination, of no value to our readers is unhesitatingly consigned to the waste basket.

Finally, since the news space is not for sale, we guard its high standard by wielding a blue pencil consecrated to the service of our readers.

All of which should make the New Instruments Section somewhat more valuable to *you* than the automobile section of your favorite Sunday paper.

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To Subscribers

We are grateful for the prompt and large-proportion response to our recent questionnaire. If you are one of the few who have not yet filled it out, won't you please do so now? It only takes a minute, and it is a great favor to us. If you have mislaid the four-page circular, another will be sent you on request.

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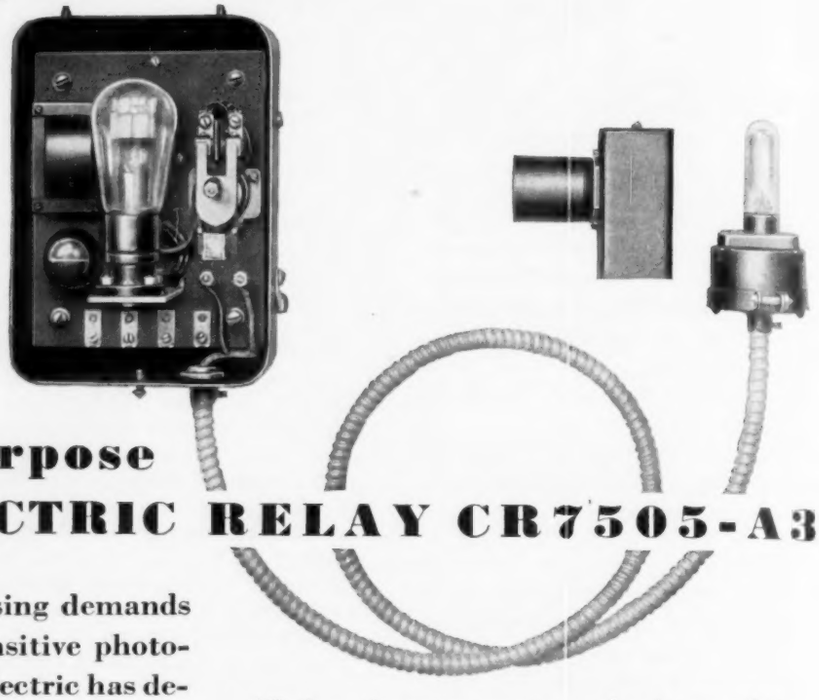

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GENERAL ELECTRIC

Instruments Help to Build and Sustain a New Industry

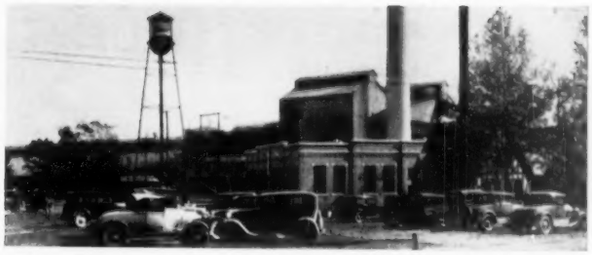


Fig. 1. A view of the Masonite Corporation, showing portions of the office and the Research Laboratory in the foreground.

By W. A. COTTON, Jr.*

SEVEN years ago two men were so intently watching the rise of the tiny thread of mercury in a thermometer that they scarcely heard the roar of two energetic blow torches near their ears. These torches were hurling their terrifically hot, almost invisible blue flames against a short section of hollowed steel shaft. Within that steel shell were enclosed a small quantity of yellow pine chips and a few drops of water.

The men were attempting to heat the water in their improvised gun until a steam pressure of 1000 lbs./in.^{2} was obtained. Pressure gages of that capacity were not available in their laboratory at that time and so a thermometer placed in a well in the shaft was used to tell what pressure was being generated within the cylinder.

Higher and higher the mercury climbed. Now it reached 500°F., equivalent to a pressure of approximately 700 lbs./in.^{2} In a few seconds it indicated 850 lbs. and the men glanced anxiously at the yoke and pin that were holding the tapered plug in the mouth of the gun. Would the plug stay in place for another 150 lbs.?

As the men watched breathlessly the mercury reached 547°. A thousand lbs./in.^{2} at last. The gun had held. Quickly the blow torches and the thermometer were removed. Tense with nervous excitement the two men hurried to the door of their crude laboratory. Once outside with a protecting partition between them and the gun, they felt more at ease. But the important part of the experiment was yet to be performed. The gun must be discharged.

To do this the younger man of the two took a long stick to which was attached a common hammer and reaching back into the laboratory, knocked the pin from between the plug and yoke with a sharp blow.

A deafening roar resounded throughout the little building. Steam filled the room and hung as a heavy curtain hiding the results of the test from the eager men as they peered questioningly into the cloud of vapor. What would they find? After a seeming age of waiting the atmosphere cleared a trifle and into the room darted the experimenters. Before them on the floor and walls was a mass of fine wood fibers. The experiment was a success. Wood could be converted into fiber by exploding chips with high pressure steam.

The thermometer played an important part in that first experiment carried on by Mr. W. H. Mason, the inventor of the high pressure steam explosion process, and his assistant, Mr. C. H. Westphalen. The measurement of temperature still remains an important factor in the control of production in the Masonite plant. As the plant grew from its humble start of a 3 gun, one machine and four press factory, having a capacity of 75,000 square feet a day, to its present 600,000 square feet capacity, the management, under the able leadership of Mr. J. H. Thickens, made sure that the use of instruments kept pace with the rapid growth. At the present time the plant superintendent, Mr. Westphalen, depends upon instruments to help him control operations and maintain quality production not only in the gun department but also in the three other manufacturing departments.

There are four major steps in the manufacture of Masonite products. The process consists of converting wood chips into fiber by a high pressure steam explosion process. The long, soft, moss-like fibre produced in the gun department is mixed with water and then brushed out or refined in machines similar to the Jordons used in a paper mill. The refined stock passes from the refiner department to the machine department where it is formed into a continuous sheet 50 inches wide and approximately 3/4 inch thick. This sheet is cut into 12 foot lengths which are loaded into racks holding 20 sheets each. These racks carry the wet board to the press department.

Here the product is pressed and dried in gigantic 2000 ton steam heated platen presses. The boards coming from the press department are trimmed to standard panels 4 feet wide and 8, 9, 10 or 12 feet in length.

Gun Department

Each step in the manufacturing process must be controlled carefully to assure a maximum production of a standard quality product. Just as in the original experiment, the shooting of the present guns is controlled by instruments. However, the operators now are guided by pressure gages instead of thermometers.

The gun department contains a battery of 9, 12½ cubic feet capacity, vertical guns each made of 13/4"

*Standards & Control Dept., Masonite Corporation.

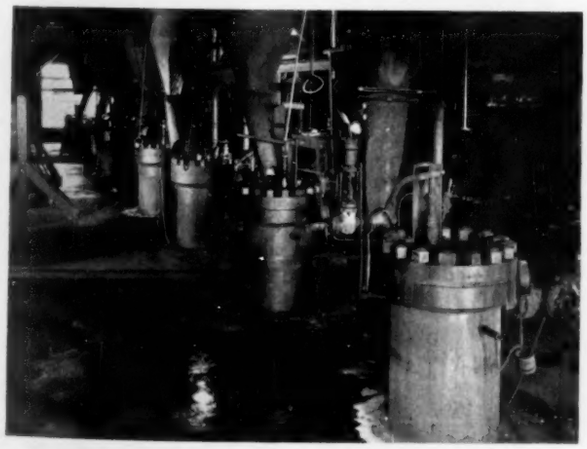


Fig. 2. A view of the gun deck showing the guns and the loading hoppers. Notice the hydraulically operated valve and the separate branch preheating line on the second gun from the right.

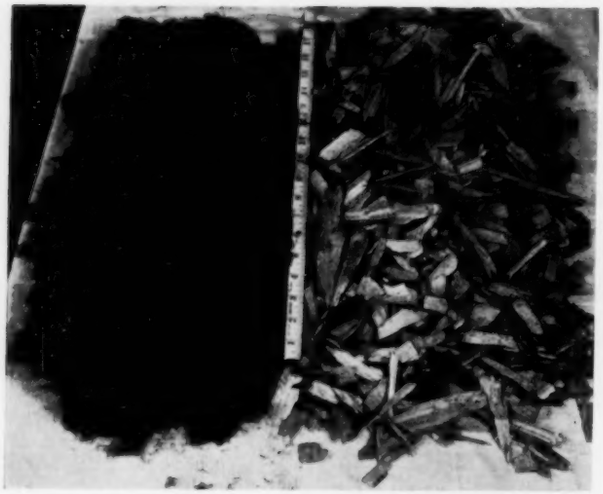


Fig. 3. The explosion process used by the Masonite Corporation converts chips similar to those shown on the right into long moss-like fibers like those shown on the left, in less than 1½ minutes.

Fig. 5. A general view of the recorder cabinet and the Insulation Unit portion of the gun deck. The recorder cabinet shows how the top 9-gun manifold was split into three 3-gun manifolds after the installation of the 3 central shooting stations. A system of valves makes it possible to operate each recorder on any one of the 3 guns connected to the corresponding manifold sections.

open hearth steel forgings built for an operating pressure of 1200 lbs./in.^{2} The guns are operated in groups of three by gunners situated in three central shooting stations. These stations are equipped with indicating pressure gages and with hydraulic control valves for the operation of the steam valves and the discharge valves of the three guns which are controlled from the respective stations.

As soon as a gun is filled with chips the loader swings the disc loading valve into place and the gunner opens the hydraulically operated preheating valve. This allows high pressure steam to enter the gun at a uniform definite rate controlled by the use of an orifice. The gunner watches the pressure gage as the gradually increasing pressure indicates the chips are preheating. When the pressure reaches the desired maximum preheating value, usually 500 lbs., the control valve is moved so that the 1" preheating valve is closed and the main 2½" steam valve opened. This operation causes the pressure within the gun to build up rapidly to the full boiler pressure of approximately 1100 lbs.

As soon as the gage indicates the maximum pressure has been reached the gunner opens the hydraulically controlled discharge valve at the bottom of the gun. The pressure within the gun drops appreciably as the load starts to discharge. When the pressure drop becomes very rapid the gunner knows the gun has been completely emptied and immediately closes the main steam valve. As soon as the charging or loading valve is opened the operator closes the discharge valve and the gun is ready for loading.

The complete cycle requires between 1 and 1½ minutes. In that short time 120 lbs. of chips, dry weight, are converted into a soft, fluffy, moss-like fiber. Hour after hour the shooting goes on with clock like precision and uniformity.

That uniformity did not just happen. Instruments played an important part in bringing about uniform operation for it was by the use of recording pressure gages that a complete analysis of the gun operations was made. To carry on this analysis the Standards and Control Department had all the guns connected to a double mani-

Fig. 4. A view of the Presdwood Unit Press Department showing parts of the 2000 ton hydraulic presses and two of the electrically driven movable racks. The presses on the right have just been closed and are drying Presdwood panels. The presses on the left are open and ready to be loaded with wet board.

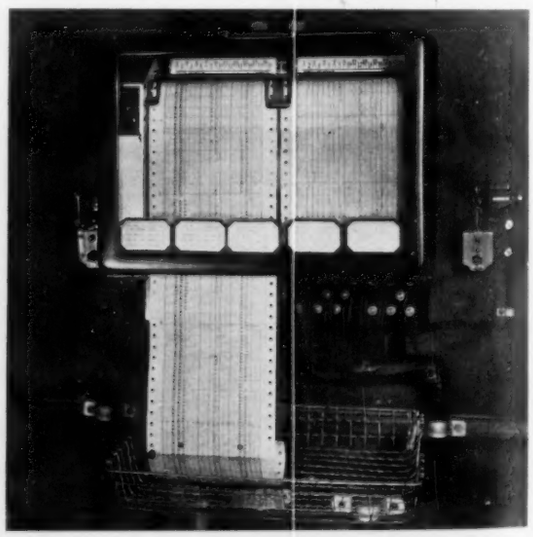


Fig. 6. A view of the 29-pen, twin chart, electric operation recorder, used to make a record of the gun, machine and press operations. The left hand chart indicates the number of gun shots made and the right hand chart shows the number of racks of board produced and records the drying times of the individual presses.

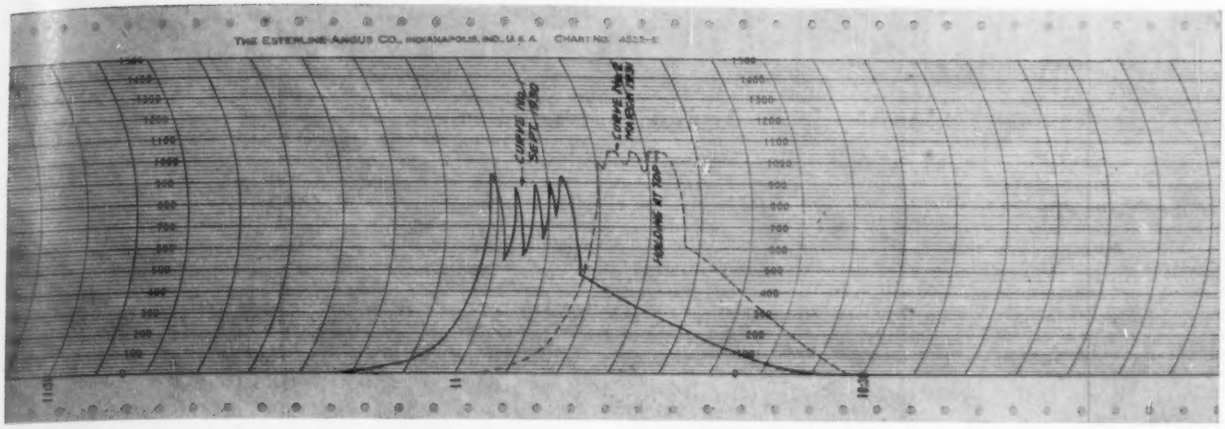


Fig. 7. This chart shows how time studies of the gun operation were made with the pressure recorders, using a chart speed of 12 inches per minute. The start of each element was marked on the zero line of the chart and identified by a letter. A special chart reel equipped with a suitable scale marked off in hundredths of a minute was used in summarizing the studies. This curve was taken from a study made in February 1930. While eight blows were not taken on all loads, shooting similar to that recorded on this chart was very common at that time. Now the guns are discharged with three short, quick, clean blows.

fold which was connected to two motor driven, Type L. R., Esterline-Angus strip chart, recording pressure gages. A system of valves made it possible to study the operations on any two guns without the gunners having knowledge of which guns were connected to the recorders.

Time studies of the operations were made using a chart speed of 12″/min. At this speed all the elements were plainly distinguishable. The charts not only gave time study data but showed a great lack of uniformity in operation. The charts indicated wide variations in the loading, the preheating and the shooting and brought to light the fact that considerable time and steam was being lost through the slow opening and closing of the hand operated steam valves. The study lead to the adoption of the central shooting stations and the installation of quick acting hydraulically operated steam valves and preheating orifices.

The recording pressure gages are now used only for spot checks on the operation or for special studies. However, their work has been well done for the analysis of the gun charts made it possible for the superintendent to detect and correct variations in the operation of the guns, with the result that the efficiency and capacity of that department has increased approximately 40%.

While the need for a record of the individual gun shots has passed, it is still necessary to have a check on the gun department as a whole. This check is made on one chart of a 29 pen, twin chart, Esterline-Angus electric operation recorder. By means of electrical contacts in the pressure gages connected to the guns, this instrument records every shot made. The record gives an accurate count of the total number of shots and indicates the chronological order in which they were made. The chart shows clearly idle gun time and consequently affords a splendid means of keeping a close check on the department throughout the day and night.

Stock Chest Instruments

In order to operate the machine department most efficiently it is necessary to have at all times an adequate supply of gun stock and refined stock ahead of the board machine. Recording liquid level gages, manufactured by the Bristol Company, are used to indicate and record the quantities of stock in the stock chests. These gages are conveniently located in the gun and refiner departments. They guide the head gunner in setting his shooting rate and indicate to the refiner man whether he is refining too much or too little stock.

The refined stock must be delivered to the board machine at a temperature of approximately 150°F. The amount of steam required to heat the refined stock depends largely upon the temperature of the unrefined gun fiber in No. 1 Chest. American recording thermometers are used to indicate and record the temperature of the stock in both storage chests. By their use the operators and superintendent are able to keep a close check on operating conditions.

(Continued on page A11)

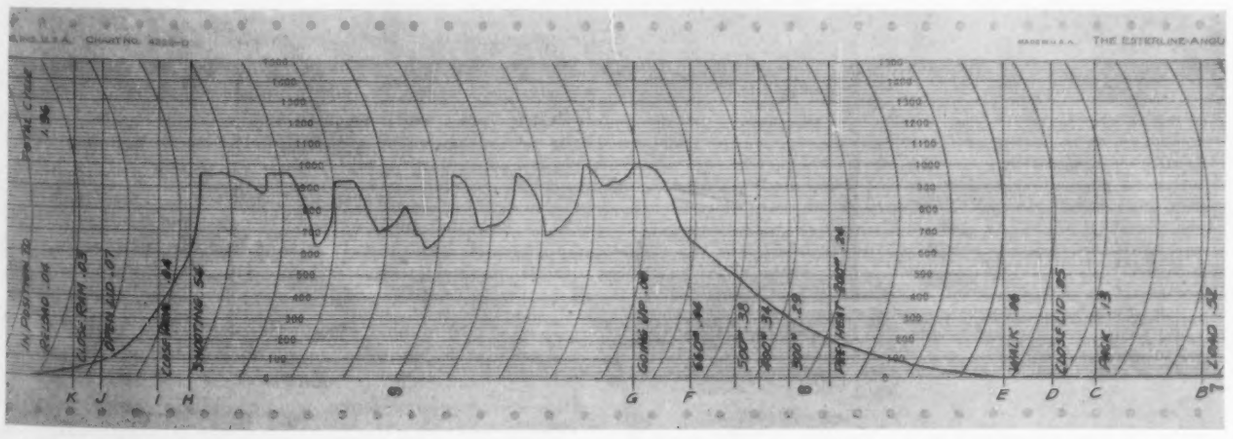


Fig. 8. A section of record chart showing the variations in gun operations recorded in September 1930 and in March 1931. These curves show how the preheating time has been reduced by preheating to a higher pressure for a shorter time. The effect of shooting at low boiler pressure is also indicated. The shot recorded by Curve No. 1 was made at approximately 900 pounds and required five blows to empty the gun. The shot recorded by Curve No. 2 was made at 1,050 pounds and required only three blows to empty the gun.

The ENGINE INDICATOR

Its Design and Theory

By KALMAN J. DeJUHASZ*

(Continued from August issue)

7. **The paper drum** is fastened to the drum base, which is mounted rotatably on an axis rigidly fixed into the indicator frame. The drum base can be rotated against the turning moment of a spring, by means of a cord wound upon the base which is formed like a pulley for this purpose. In earlier types of indicators spiral, clock-type springs were used. The helical spring was used first in the Crosby indicator and since then in virtue of its lightness, freedom from breakdown and convenient adjustability, this type of spring has been adopted by practically all indicator makers. (See Figs. 6-19.)

The rotation of the drum is limited by stops to about 300°. The paper is secured onto the drum by means of two spring clips which have to be securely fastened to the drum in order to withstand the considerable tangential forces. The diameter of the drum of a normal indicator varies from 1½ in. to 2 in.

In order to reduce the inertia effect the drum itself is made of thin gage metal, sometimes of aluminum. Several makers (Figs. 14, 15, 16) provide the drum base with two pulleys, which makes possible driving two indicators in series, i.e. driving a second indicator from the one driven from the crosshead of the engine. This, however, is not good practice, as it increases the spring loading of the first indicator drum, and may introduce an error in the proportionality of the drum displacement with reference to the engine piston travel. Because of these considerations the double pulley on the drum base is no real advantage. The second pulley can and should be dispensed with, and the drum mass thereby reduced. There are a large variety of drum designs. Some of them are provided with detent motion (Fig. 14b) by means of which the paper carrying part can be put into, and out of, engagement with the drum base. This makes it possible to change the paper without unhooking the cord, which is of advantage, especially with high speed engines. Unfortunately, this construction makes the drum more complicated and increases its inertia, which is the very thing which has to be avoided at high speed. Fig. 35a shows such a design, in which the spring loaded pin located in the drum base engages with a corresponding hole in the lower end plate of the drum proper. Lifting the drum by means of the upper knurled nut severs the connection between the two. Lowering the drum pushes the spring-loaded pin inward, until the pin comes into engagement with the hole again. Fig. 35b shows a modification in which the pin is in the drum base and the spring is located in the upper drum.

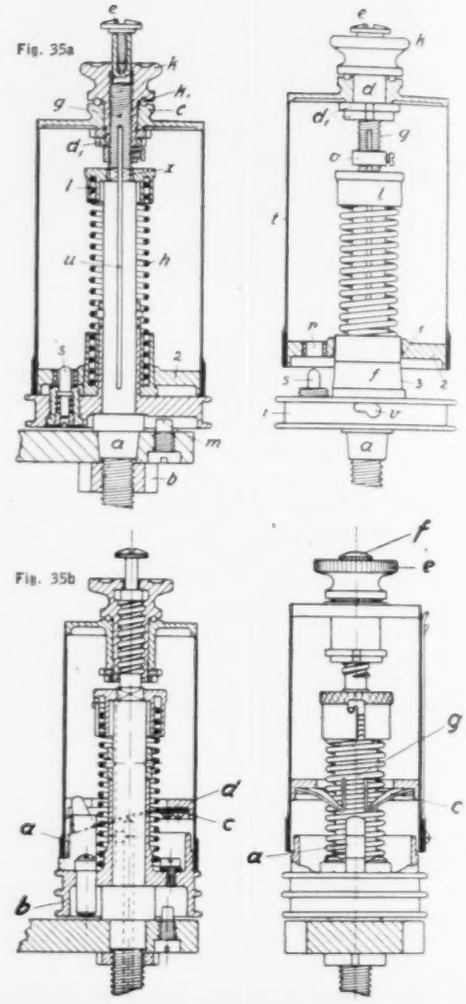


Fig. 35. Indicator Drums With Release Arrangement (Maihak). a) Operates with spring engagement pin *s* in the drum base *i*. b) has pin *a* fixed in drum base *b* and leaf spring *c* attached to drum. Note ball bearing under quick release nut *e*.

Other constructions, such as shown in Fig. 36, achieve the same results by arresting the drum by means of a stationary pawl and a ratchet on the periphery of the drum base. By this means the drum is arrested in one of its extreme positions. This construction has the advantage of lighter weight, but has the disadvantage of the cord alternately slackening and tightening at each revolution of the engine.

There are drums designed to carry a long strip of paper, on which a large number of diagrams can be taken in succession, without stopping the indicator. This is a great convenience when indicating engines with rapidly changing load, i.e. engines driving conveyors, steel mills, locomotive engines, and the like. Such a drum is shown on Figs. 37 and 37a. The strip of paper, about

*Asst. Professor of Engineering Research, Pennsylvania State College.

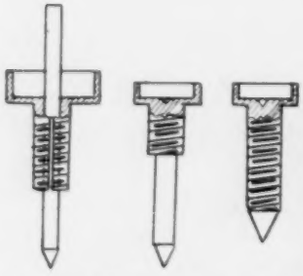


Fig. 33. Different Constructions of Pencil

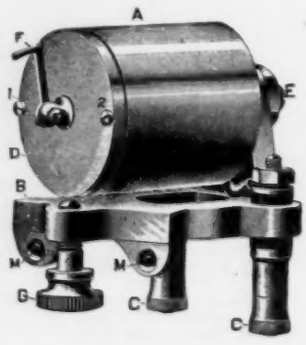


Fig. 34. (at right) Electromagnetic Actuator for Pencil. (Crosby-Sargent.) Latch F pulls pencil platform towards indicator drum when electric circuit is closed.

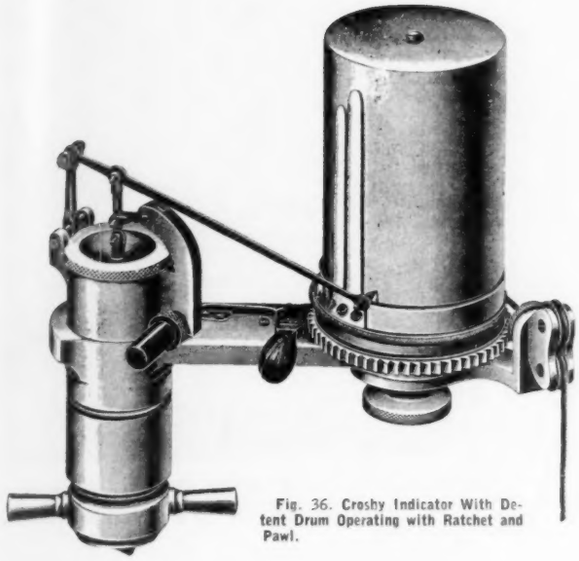


Fig. 36. Crosby Indicator With Detent Drum Operating with Ratchet and Pawl.

12 ft. long, is wound on a supply spool inside the drum. From this it is unwound and wound onto another spool inside the drum, about 1 inch at each to-and-fro motion of the drum. This action is accomplished by means of a ratchet and pawl mechanism arranged on the top plate of the drum. As a result the diagrams appear staggered; each is distinct from its neighbors and can be analyzed without difficulty. The ratchet and pawl mechanism can be placed out of action at will and the drum be used as a normal drum. By putting the ratchet into action for a few strokes and taking no diagrams, then, by placing the ratchet out of action and taking a diagram, the whole strip of paper can be filled with normal (not staggered) diagrams, without stopping the drum motion. This feature is especially useful with remote control indicators, i.e. when indicating a locomotive engine. Owing to the large masses involved this construction does not lend itself for high speed service, but for comparatively slow speed engines it fulfills its purpose well.

Another construction for staggered diagrams is shown on Fig. 37b.

There have been drums built for taking pressure diagrams on a time or crank-angle basis. This can be accomplished simply by means of a drum of large diameter, if the pressure phenomenon to be recorded is of short duration, or only one or two diagrams are required. Fig. 38 shows a heavy drum, mounted on ball bearings, which can be spun by hand. Recording numerous diagrams requires using a long strip of paper and unwinding it from a supply-spool onto another spool. For such applications an electrical marking device is usually provided, in order to denote on the chart time-units, or characteristic reference points.

For special purposes a type of drum has been developed by the Crosby Company to the design of Prof. Lanza, for taking open diagrams on a piston stroke basis. (Fig. 39). In the dead centers of the crosshead the drum comes to a standstill, and then continues its travel in its former direction. The diagram thus obtained presents the pressure changes in a clearer manner than the conventional closed card. Besides the drum proper, there is a supply spool and another spool onto which the used paper is wound. A base line is drawn by a stationary pencil which also marks on the paper the end of each stroke.

Another design, developed by the Trill Indicator Company, for a similar purpose, is shown on Fig. 39a.

8. The cord pulley is rotatably mounted with its pivot on a swivel bracket, which in turn can be rotated around the drum axis as a pivot. It serves the purpose of guiding the cord from the crosshead tangentially onto the drum pulley. For this purpose the cord pulley is mounted in the bracket in such a manner that it has, in all its possible positions, a tangent common with the drum pul-

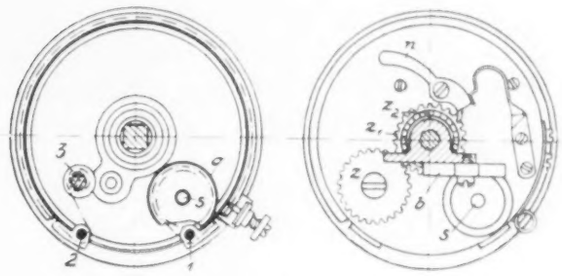


Fig. 37

Fig. 37a

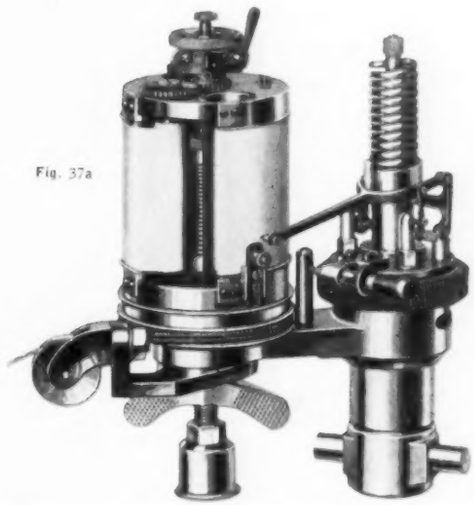


Fig. 37. Drum For Taking Consecutive Diagrams on a Long Strip. Each Diagram is displaced slightly and is clearly distinct from its neighbors. Strip is wound off supply spool s onto receiving spool 3 by means of ratchet mechanism n z. a) Shows photo of drum with auxiliary pencil for marking atmospheric line (Maihak).

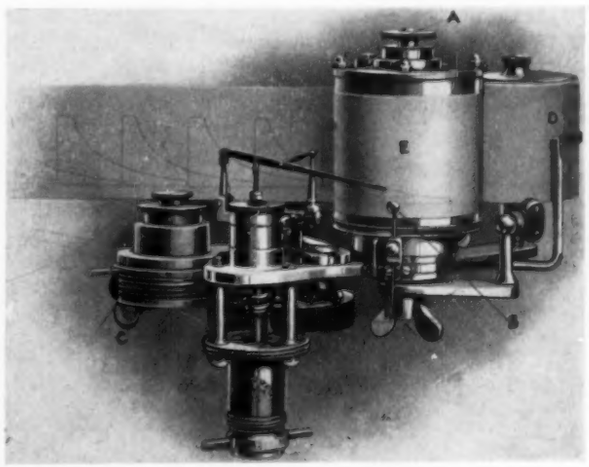


Fig. 37b. Indicator fitted with drum for taking continuous, closed type, diagrams. *D*—supply spool (taking about 200 ft. paper strip); *E*—drum; *B*—atmosphere line marker. (Trill Indicator Co.)

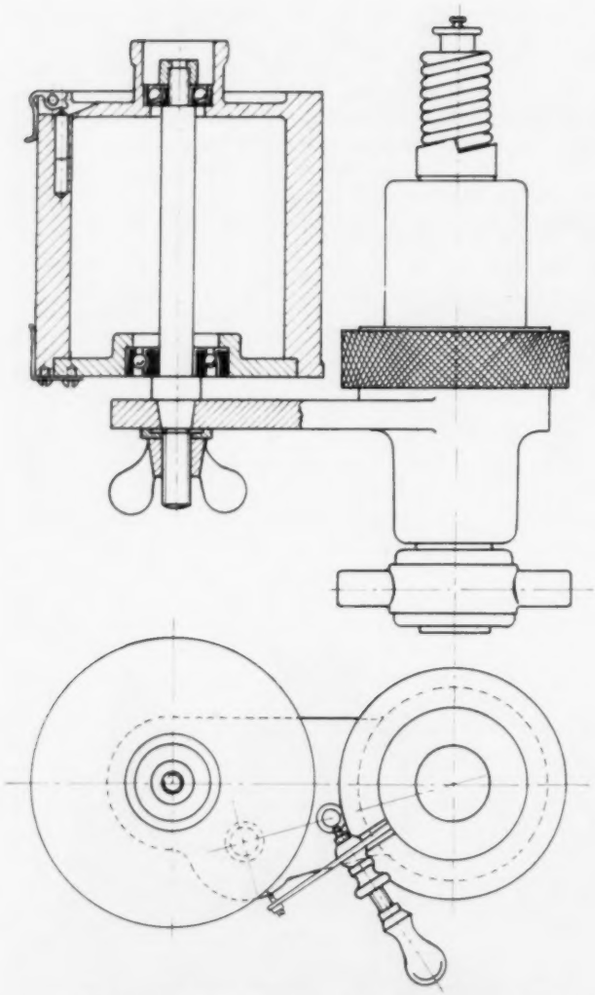


Fig. 38. Indicator With Drum Having Large Inertia For Taking Pressure Diagrams on an Extended Time Scale. Drum is fitted with ball bearings and can be spun by hand. Note design of paper clip. (Lehmann & Michels)

ley. On the other hand, it can always be brought into such position that it has a tangent coincident with the direction of the cord coming from the engine crosshead or reducing motion gear. Consequently, in this position the plane of the pulley coincides with the plane of the two intersecting tangents.

This requirement still leaves one degree of freedom for the positioning of the cord pulley. From among those mentioned above the one with the most obtuse angle enclosed by the tangents provides the least stresses for the pulley and cord. The cord pulley pivot and its bracket have to be clamped in this position.

In a number of indicator types, two pulleys (Figs. 6, 14) mounted on the same pivot, are used, with the purpose of preventing the slipping off of the cord. Actually, however, there is only one pulley necessary, because the cord cannot slip off from a properly positioned cord pulley, provided the cord is kept taut at all times. (Figs. 12, 13, 16.)

Fig. 40. Guide Pulleys for the Indicator Cord. a) Lehmann and Michels uses two pulleys mounted on a bracket which can swivel in every direction. b) Dobbie McInnes is a combination of a ring and a pulley.

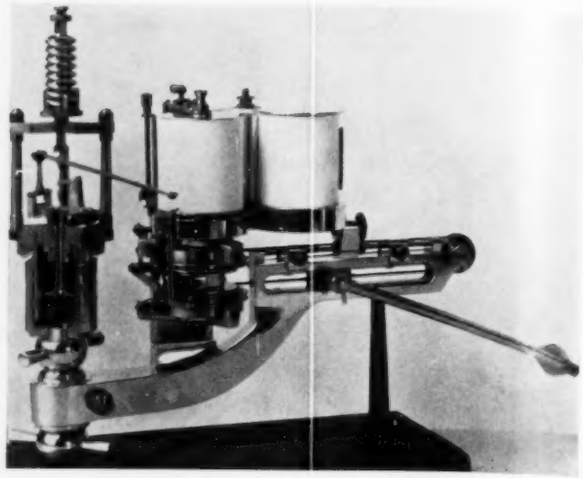


Fig. 39. Crosby-Lanza Drum on Crosby Indicator. This gives open diagrams on piston stroke basis. The drum is rotated continuously in one direction by the alternate engagement of two series of clutches actuated by a crosshead block moving in unison with the engine piston.

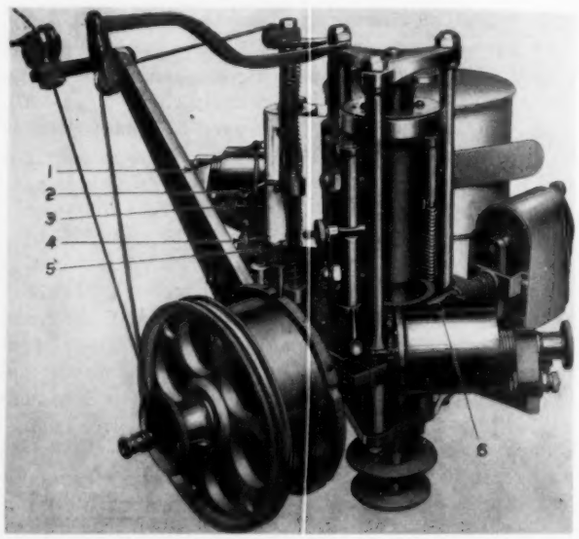


Fig. 39a. Drum attachment for taking continuous, open type, diagrams: 1—indicator pencil arm; 2—locates piston stroke; 3—locates dead center; 4—atmospheric line marker; 5—time marker. (Trill Indicator Co.)

In cases where the cord has to change its direction in order to clear some machine part or other obstacle, a separate cord pulley has to be used at the point of change. Such pulleys, shown in Figs. 40 a and b, can be positioned in any desired direction.

THE DRUM DRIVE

It is necessary that the angular displacement of the drum shall be exactly proportional to the variable such as time, crank-angle, or piston stroke, on the basis of which the pressures are to be recorded.

Generally, a pressure-volume diagram is sought. The engine stroke being, as a rule, longer than the available part (an arc of about 300°) of the drum circumference, means have to be employed whereby the engine stroke

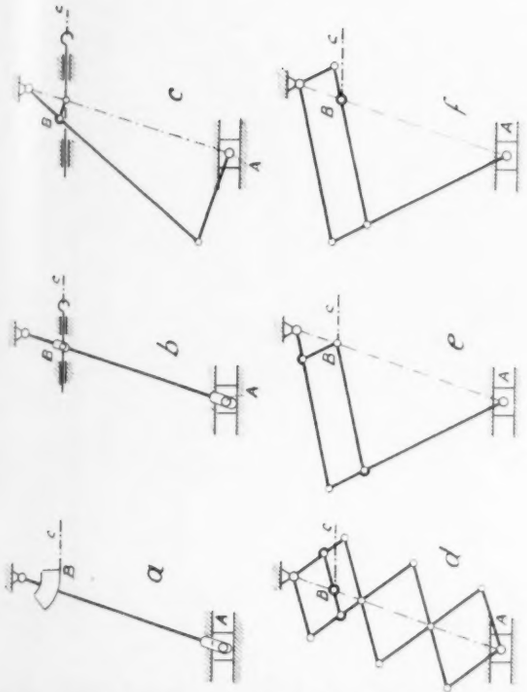


Fig. 41. Various Forms of Lever Type Stroke Reducing Gear. a) Slide-Block A and Segment B. b) Two Slide-Blocks A and B. c) Two Slide-Blocks Attached to Lever Arm with Two Connecting Rods, d, e, f) Three Modifications of the Pantograph.

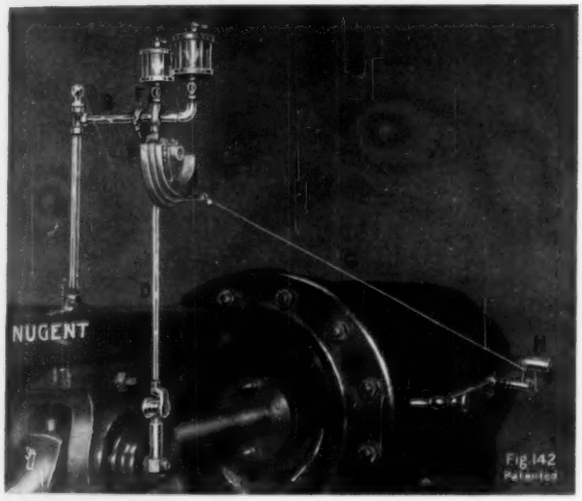


Fig. 41g. Nugent's Brumbs Pulley reducing gear attached to telescopic crosshead pin oiling device (Wm. W. Nugent & Co.). This device has a five step pulley making it possible to adjust the diagram to five different lengths. E—indicator reducing motion, F—clamp and arm supporting the guide pulley G; H—the indicator.

is reduced in exact proportion. The reducing device can be one of the following types:

1. Lever-type;
2. Pulley-type; and
3. Crank-type.

The first two types derive the motion from some reciprocating part of the machine, usually the crosshead or piston, while the third type is driven by the crankshaft or camshaft. Given suitable proportioning of the parts every type is capable of providing accurate proportionality for the reduced motion.

A few examples of the lever-type reducing gear are shown schematically in Figs. 41 a-f. In these figures A is the pivot fixed to the engine crosshead, B is the point

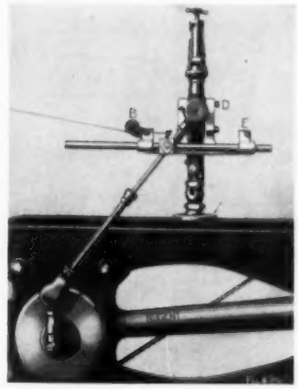


Fig. 41h. Nugent's Indicator Reducing Gear attached to telescopic crosshead-pin oiling device (Wm. W. Nugent & Co.). The oscillating block, guided by two horizontal tubular guides, reproduces on a smaller scale the motion of the piston. The block is moved to and fro by the telescopic tube of the oiling device. (This latter is shown in section in Fig. 41i.) A pin which is free to turn passes horizontally through this block which is bored to allow the telescopic tube to pass through. The

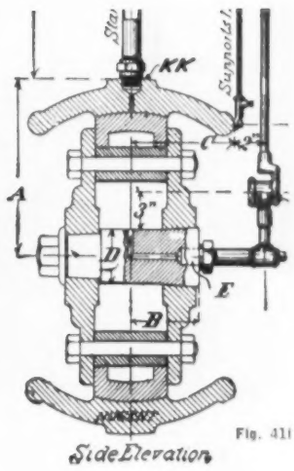


Fig. 41i

indicator cord is attached to this pin and on its way to the indicator passes through a swivel guide pulley. The device reproduces the motion of the piston accurately and can be easily attached to, or removed from, the oiling device.

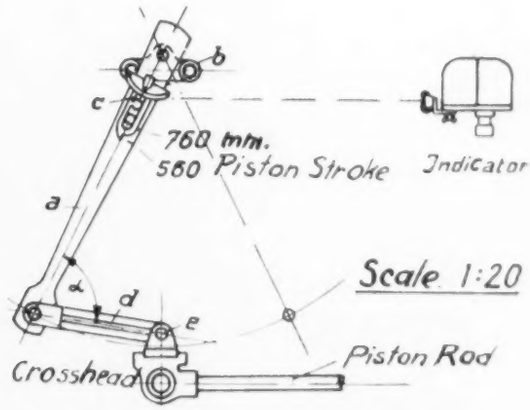


Fig. 42. Actual Design of Reducing Gear for Locomotives. Position of segment is adjustable to give the same diagram length with various stroke lengths. Lever is made of hardwood with metal reinforcement on the ends. (Lehmann and Michels)

to which the drum cord is fixed, and c is the direction of the cord motion at the initial point. These are usually built of hardwood or of metal rods. It is important to avoid slackness in the joints. They must, therefore, be sufficiently light and of low inertia. This type of reducing gear is usually fitted to an individual engine as a permanent or detachable mounting, and is not adapted for transfer to another machine. The telescopic crosshead pin lubricators of the Wm. W. Nugent Co. (Fig. 41a, b and c) are adapted, in an ingenious manner, to also serve as reducing gear for the indicator drum, one of them, with a Brumbs pulley giving an approximately proportional, the other with the sliding block, giving truly proportional reduction. Fig. 42 shows a drive used on locomotives; Fig. 43 and 44 are designs used on vertical Diesel engines.

The pulley-type reducing gear is well adapted for use on different engines. It consists of a large pulley upon which is wound the cord connected to the engine crosshead. Keyed onto the same shaft is a small pulley upon which is wound the cord connected to the indicator drum pulley. In most constructions there is a spiral or helical spring incorporated in the large drum itself. Other constructions are springless and rely for the return motion solely on the drum spring of the indicator.

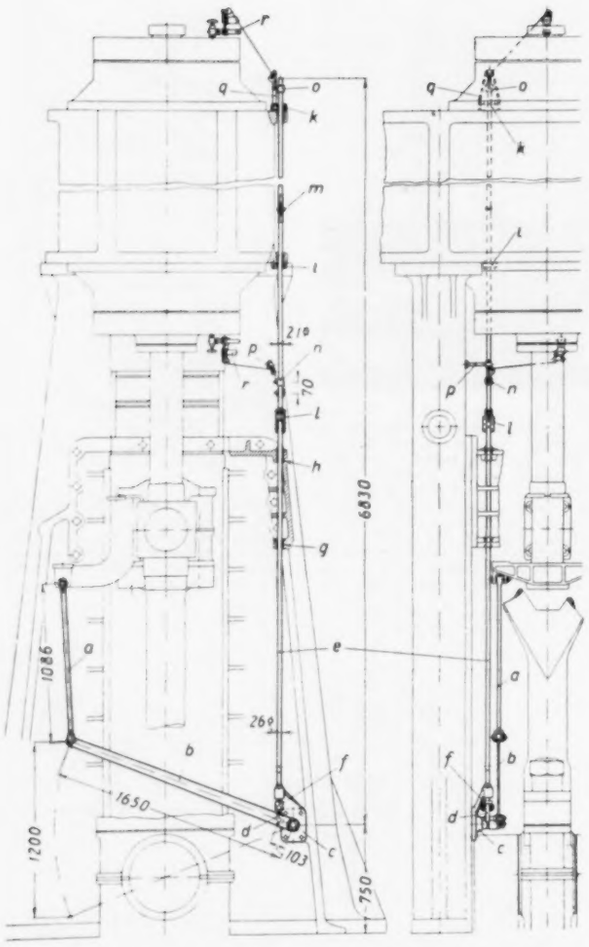


Fig. 43. Reducing Gear for Diesel Engine. (Sass "Kompressorlose Dieselmaschinen" published by Julius Springer, Berlin)

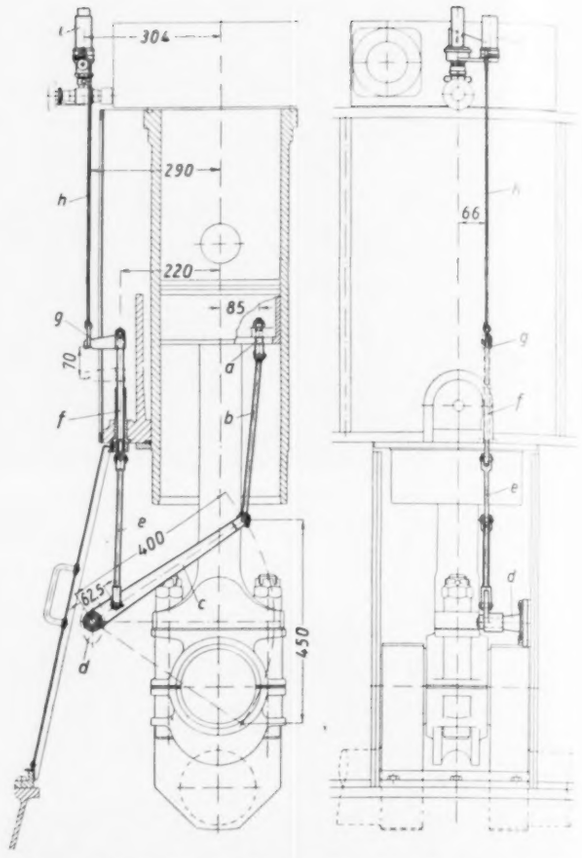


Fig. 44. Reducing Gear for Diesel Engine. (Sass "Kompressorlose Dieselmaschinen")

The small pulley is interchangeable so as to accommodate various ranges of piston strokes. Various forms of reducing pulley are shown in Figs. 45, 46, 47. A good reducing pulley should have sufficient rigidity and small inertia—for which reason the large pulley is often made of aluminum. An advantage is its easy adaptability to different engines, as it forms part of the indicator rather than of the engine. A disadvantage is, however, that it entails the use of a long cord and a high velocity for the cord. The stretching resulting from the accelerations may introduce undesirable errors.

The crank type reducing gear is in effect equivalent to providing a small crank-connecting rod mechanism, having the same geometrical proportions as the engine. It has the advantage that the speeds of all the moving parts of the gear are reduced, which is a desirable feature from the point of view of safety, wear and tear, and errors caused by acceleration. Furthermore, offset diagrams can be taken, which is not possible with the previously described types. On the other hand, it requires great care in its mounting in order to ensure that the dead center position of the reducing gear coincides with that of the engine. Also, it requires an accessible shaft-end upon which it has to be mounted.

Such a reducing gear is shown in Figs. 48 and 49. Another type (Maihak or Lemag) is used for high speed engines and has a constant stroke, but adjustable r/l ratio. (Figs. 51, 52.)

Often the connecting rod is omitted and the cord is

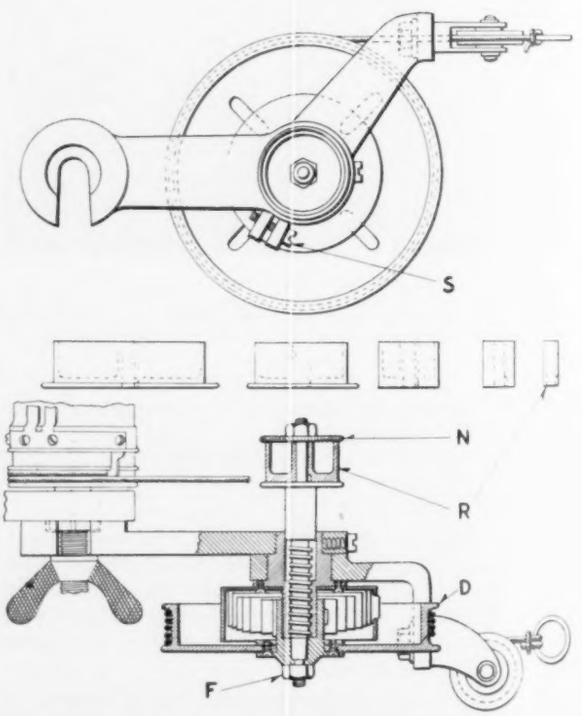


Fig. 45. Pulley Type Reducing Gear (Maihak) with return spring and interchangeable pulleys for accommodating various engine stroke lengths.

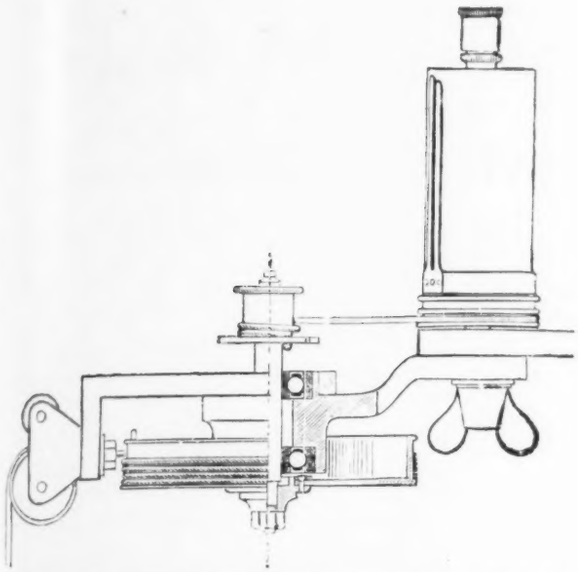


Fig. 46. Pulley Type Reducing Gear (Lehmann and Michels) without return spring. Pulley shaft rotates on ball bearings.

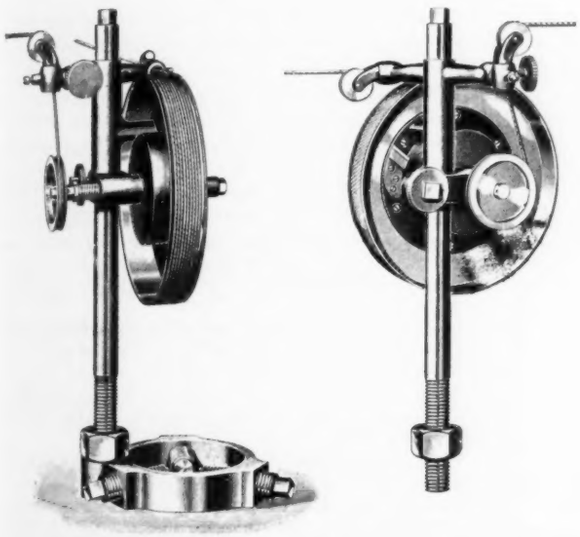


Fig. 47. Pulley Type Reducing Gear (Schaeffer and Budenberg) without return spring. This device is mounted on a post independently from the indicator.

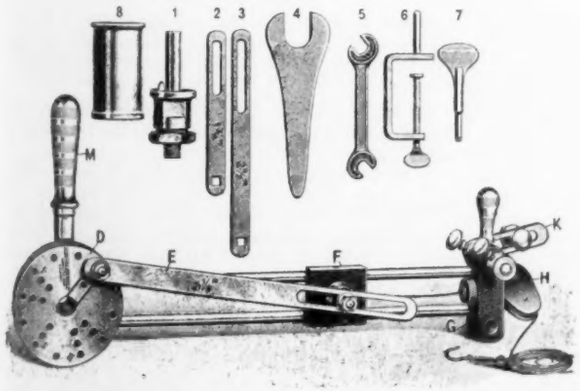


Fig. 48. Crank Type Reducing Gear (Schaeffer and Budenberg-Graham) With Adjustable r/L Ratio Giving Accurate Proportionality. Gear can be thrown out of action during the running of the engine and phase can be changed. Shows component parts, tools and accessories.

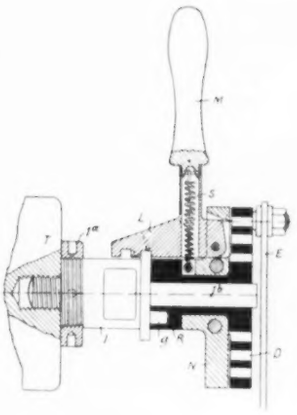


Fig. 48a. (at left) Cross Section of Crank Type Reducing Gear

Fig. 49. Graham's Simple Reducing Gear which can be clamped on the free end of the engine shaft. Throw of crank D can be adjusted to give diagram length desired.

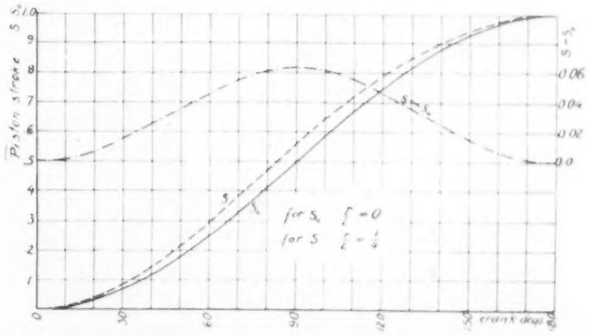


Fig. 50. Chart Showing Error If Drum Motion is Obtained Directly from the Crank of the Reducing Gear By Means of a Long Cord, Without a Proper Connecting Rod. The error is the greater the smaller the r/L ratio of the engine.

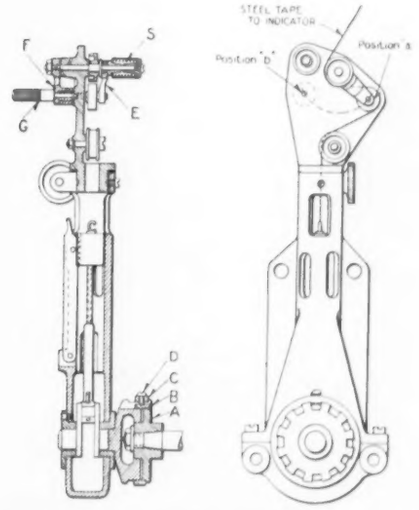
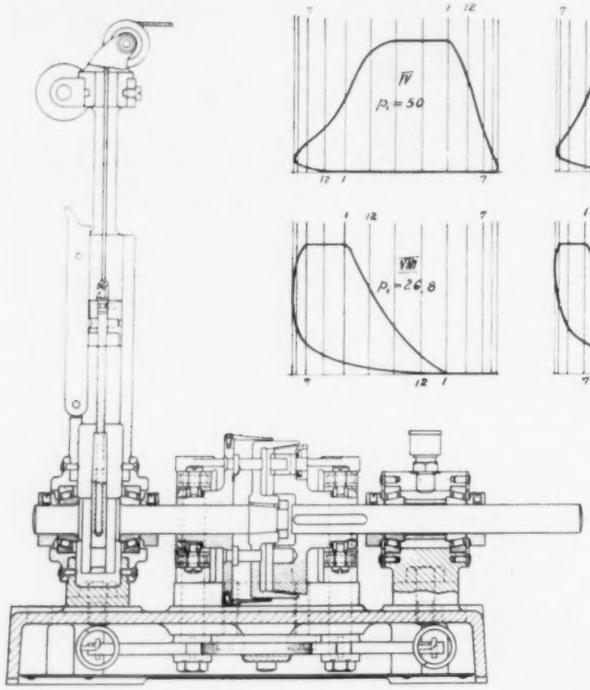


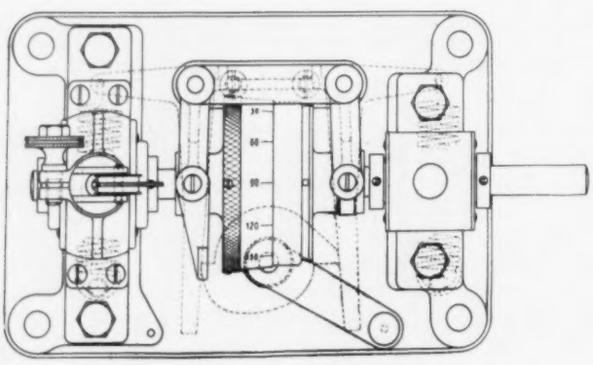
Fig. 51. Drum Drive for Maihak High Speed Engine Indicator. Hub Disk A is bolted to the end of the engine shaft and the housing of the reducing motion is fastened to the engine. The crankshaft of the reducing gear is coupled to the hub disk by means of key B and the carrier ring C. The edge of the hub disk is provided with 12 keyways set at every 30°. Thus the crank of the reducing gear can be put into phase with each crank of a 6 throw (or even 12 throw) crankshaft. The r/L ratio of the gear can be set to any desired value by shortening or lengthening the connecting rod.

hooked right on the small crank (Fig. 49). In effect this amounts to a very long connecting rod. This represents an error, which is the greater, the greater the r/L ratio. The magnitude of the error is shown in Fig. 50.

It is very important that the dead center of the drum motion coincide exactly with the dead center of the

Fig. 52. Further Development of the Coupling shown in Fig. 51 enabling the phase to be changed without stopping the engine. A coupling is interposed between the shaft of the reducing gear and the engine shaft, which can be put into or out of operation at will. Taper roller bearings are used on the shafts.





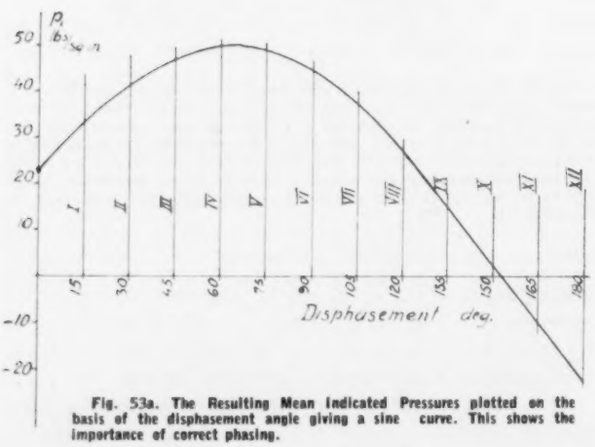


Fig. 53a. The Resulting Mean Indicated Pressures plotted on the basis of the disphasement angle giving a sine curve. This shows the importance of correct phasing.

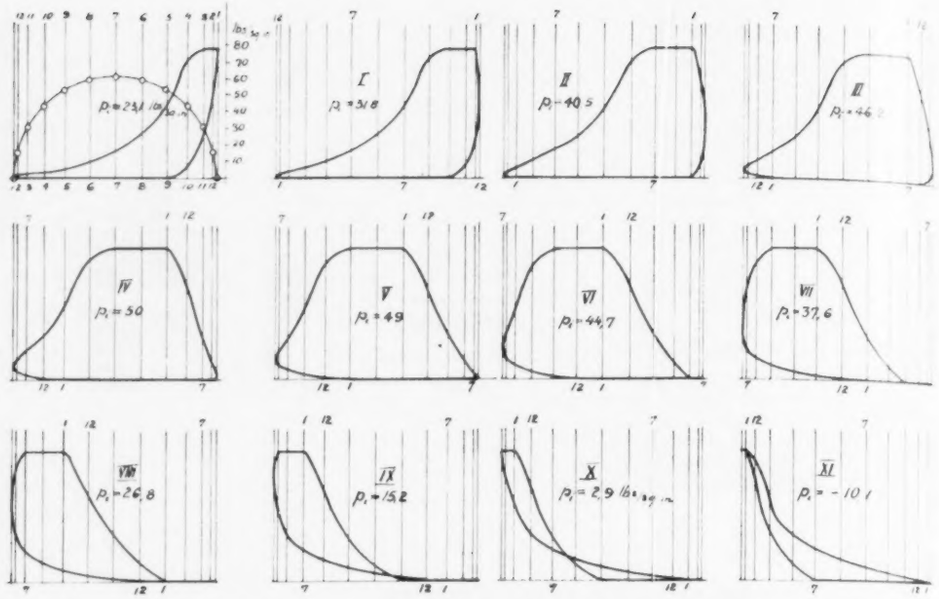


Fig. 53. Effect of Disphasing the Drum Drive With Respect to the Engine Piston. The resulting diagrams are shown for every 15° disphasement.

engine. If there is a phase difference between the two then the diagram yields a false mean effective pressure. The error resulting from this source is illustrated in Figs. 53 and 53a, showing that the mean effective pressure, as derived from the indicator diagram, changes according to a sine curve, which is a function of the angle of phase difference.

FINDING THE DEAD CENTER OF THE ENGINE

The exact position of the engine flywheel corresponding to the dead center can be found by halving the angle between two flywheel positions corresponding to the same piston position. The procedure is as follows:

1) To a stationary part of the engine secure a pointer (made of strong wire or steel strip) nearly in contact with the flywheel.
2) Turn the flywheel and bring the crank into a position about 20° from the dead center, and make a mark on the flywheel at the tip of pointer.
3) Make a continuous pencil mark, or scratch, across both the crosshead and one of the guides. Or, if these are not accessible (or not existent as in a small internal combustion engine), then measure through the spark plug hole the distance of the piston from a stationary point by means of a depth gage.
4) Turn the flywheel past the dead center until the crosshead, or the piston, comes back again into the same position as under 3). Make another punchmark on the flywheel at the tip of the pointer.
5) Bisect the angle between the two marks on the flywheel and mark this point with a heavy punchmark. Bring this point under the pointer. The piston is now accurately in the dead center.

In the case of offset engines this method is not correct theoretically though it is practically so, provided the two angles are small (about 10°).

If the fastening of the pointer is difficult then it can be dispensed with and a pair of dividers can be used, one leg of which is placed into a punchmark on the stationary part of the engine (f.e. on the frame, or bedplate) and the other leg placed into the punchmarks on the flywheel. (See also: Shoop & Tuve "Mechanical Laboratory Practice." McGraw-Hill Book Company.)

The cord connection to the indicator drum has to be straight and short. The cord itself must be flexible and with as little stretching as possible. Braided cord gives less stretch than a twisted one, and steel wire is still better in this respect. If the connection is long, in the

(Continued on page A11)

Flow Measurement and Control†

By M. F. BEHAR**

CHAPTER XXIV
CURRENT METERS

1. Meters Included in "Current" Class

With this chapter we begin consideration of inferential meters, those through which or past which the fluid flows in a continuous stream instead of passing through in separately isolated quantities.

(a) What Are Current Meters?

Most of the methods and instruments dealt with in this chapter are used in several distinct technical professions—nautical, aviation, irrigation, waterworks, hydraulic power, mine ventilation, hydrographic surveys, etc.—as well as in the test metering and routine metering of fluids in industrial plants. Identical methods and instruments, in some cases, are given different names in different fields; and engineers in various fields may use identical terms when speaking of different instruments. Under current meters some authorities include not only devices having rotating elements but also Pitot tube outfits. Others restrict current meters to devices for measuring stream-*section* velocity and exclude meters *through* which the entire stream passes; others, dealing only with natural and other open streams, imply that a rotating-element instrument ceases to be a current meter when installed inside a pipe in an industrial plant. To some hydraulic specialists, cup anemometers are not current meters because they are not water measuring instruments. All have their reasons; some have stated them; some of the reasons apply to the individual writer's professional field.

As set forth in Chap. XXII, the A.S.M.E. Fluid Meter Committee's scheme of classification is followed in the arrangement of this handbook. Accordingly, this chapter covers devices that belong in the committee's "Class 2.1—Current (Kinematic)" in "Division 2—Inferential," also in "Group I—Quantity."

Note the unique place of current meters in this scheme: they are the only quantity meters in the inferential division and the only inferential meters in the quantity group. Recent developments, however, have made the Committee's rigid system somewhat obsolete and we cannot* adopt the implied literal definition, "A current meter is an inferential quantity meter."

In order to arrive at an unimpeachable definition of the class it is necessary first to review those given by various authorities and accepted in various fields of technology.

(b) Hydraulic and Hydrographic

In the chapter on "Service Meters" of the *Waterworks Handbook* by Flinn, Weston and Bogert (3rd ed.) we find a section on "Velocity Meters." After this heading comes a parenthetic remark: "(also known as 'current,'* 'turbine' and 'torrent')" and the footnote reads as follows: "*The name 'current' is objectionable and confusing, because it has so long been used for stream-gaging meters." This section on "Velocity Meters," by the way, refers entirely to what we call turbine meters.

In his book, *Stream Gaging*, Liddell states:

> There are two classes of current meters, one depending directly upon the velocity of the water for operation, and the other upon the pressure of the water. The meters with the revolving element are of the former class and the Pitot tube and various types of pressure plates, of the latter.

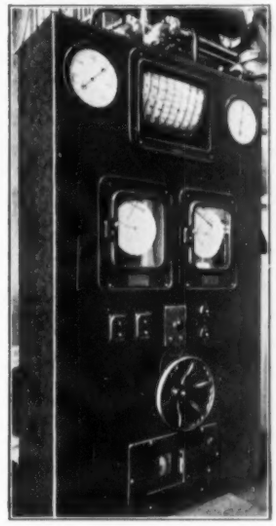
The *American Civil Engineers' Handbook* edited by Merriman and Wiggin (5th ed.) states under Measurement of Water:

*It is not the author that presumes to challenge the validity of his colleagues' report: it is the emergence of new facts—new instruments, new uses and new trends—which invalidates a small portion of this useful work.

†Part Six of *The Manual of Instrumentation*.

**Engineering Editor.

FOR BOILER CONTROL



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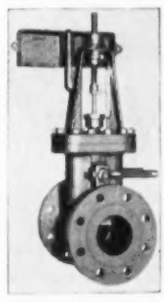

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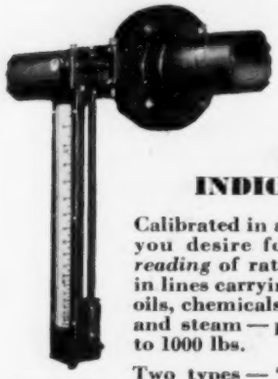

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The current meter consists usually of a revolving device, driven by the current, the *revolutions of which bear some relation to the velocity of the water*, and are transmitted to some form of a recording or sounding apparatus whereby the number occurring in a given time may be observed. Two types . . . the screw or direct acting-meter, and the cup or differential meter.

The italics are ours. No mention is made of the turbine type but, on the other hand, neither Pitot nor pendulum meters are included.

From the most informative recent technical paper on (water) current meters, that by Yarnell and Nagler:*

The current meter is an instrument commonly used to obtain water velocities . . .

Current meters are made in various styles, but all have a rotating element, called the wheel or propeller, actuated by the moving stream . . .

The current meters in common use may be classified as of two types: The cup type in which the wheel rotates about a vertical axis; and the screw type in which the wheel or propeller rotates about a horizontal axis, ordinarily intended to be held parallel to the direction of flow of the stream.

(b) Aerodynamic

Report 420 (July 1932) of the Nat'l Adv. Com. for Aeronautics, on *Aircraft Speed Instruments*, divides these into (1) differential pressure, (2) mechanical and (3) thermal. Extracts from the chapter on the mechanical class:

The first and most important group includes all instruments having an element which is set into rotation by the air stream. . . . The axis of rotation of the element may be perpendicular to the direction of the air stream, as in the Robinson cup anemometer, or it may be parallel to the direction of the air stream, as in the vane or windmill form of anemometer. . . . In the second group are instruments with a member or element which is deflected against a restraining spring (or gravity) by the direct impact of the moving air. . . . The Robinson cup or the vane anemometer may be converted into a deflection instrument by restraining the motion of the element by a spring. Such instruments are known as bridled anemometers.

(d) Mechanical Engineering

In Vol. I (Engineering Instruments) of *Experimental Mechanical Engineering*, Professors Diederichs and Andrae distinguish between "open" and "closed" *volume* meters and between "open" and "closed" *current* meters. A few extracts to show also their scheme of classification:

[Page 477] **7. Volume Meters.**—These are of two types: *open* and *closed* meters. In the former the liquid is not under pressure, and the operation is quite like that of the weighing meters just discussed, whereas in the latter the liquid may be handled under any pressure. . . .

[Page 484] *(d) Turbine or Current Meters.*—The closed meters to be described under this head must not be confused with the current meters classified under rate of flow meters, which are used in open channels. . . .

[Pages 490 *et seq.*] **10. Current Meters.**— . . . . used only for the measurement of liquids in open channels . . . . *(a) Floats* . . . . . *(b) Current Meters.* — . . . consist essentially of a wheel . . . number of turns made in a given time is a measure of the velocity of water . . .

Note that Diederichs and Andrae take up "closed" current meters (turbine meters) under "Volume" meters and hence under "Positive" meters. But their view of positive meters is radically different from the one held by the A.S.M.E. and by the author, as is evident from this further quotation:

[Page 488] **8. Characteristics of Positive Meters for Liquids.** — . . . . All the closed positive meters have a lower limit of flow below which they will not register. . . . The manufacturer's rating . . . is the only source of information on this point. Below the limits stated, the meters begin to lose accuracy very rapidly, and the registration soon stops completely, with the result that considerable quantities of liquid may pass unmetered."

These statements appear under "Methods of Measuring Water;" the following appears under "Methods of Measuring Gases":

[Page 603] **46. Anemometers.**—These instruments are current meters . . . The essential point of difference . . . is that in anemometers we are dealing with fluids of low density . . .

We quote at length from Diederichs and Andrae because their monumental work has for years represented and influenced the attitude of American mechanical engineers with respect to engineering instruments, and because the instruments they call current meters, though under headings utterly at variance with the A.S.M.E. Fluid Meter Committee scheme, correspond to the instruments which that Committee considers to be current meters. And now to quote from the Committee's report:

"Current" meters are those in which the primary element is some device which is kept in continual rotation by the linear motion of the stream in which it is immersed. The secondary element is, essentially, a revolution counter and the instrument measures the total distance of travel of the fluid past the primary device. By suitable graduation of the dials this distance may be multiplied by the sectional area of the stream so that

*D. L. Yarnell and F. A. Nagler, Effect of Turbulence on the Registration of Current Meters. Also 13 discussion papers. *Trans. Am. Soc. Civil Engrs.* Vol. 95 (1931), pages 766-860.

the meter reads directly the total volume passed through. For a fluid of known density the dials may evidently also be made to read weights instead of volumes.

In this respect the current meters resemble the positive meters which give total quantities directly and not rate of flow. They are radically distinct from the positive meters, however, in that they do not pass the fluid through in separate isolated portions. The primary device need not take up the whole cross-section of the stream and fluid may pass through with little obstruction, even though the mechanism is blocked.

This lucid statement—never changed in the successive editions—explains why the committee excludes pendulum, vane and other devices included by hydrographers and civil engineers. From the wording, too, it seems that the committee understands a current meter to combine a rotor and a *counter*—not a tachometer—which may explain why the committee unqualifiedly assigns current meters among quantity meters, not among rate meters, nor a-straddle on groups I and II.

Actually, the majority of current meters are registering, not indicating, instruments. Were it the other way about, would not current meters be placed among rate-of-flow meters?

Historically, too, *all* current meters were registers from their invention by two 18th century French scientists until the practical combination of a rotor with a tachometer by a 20th century international combine. Had it been the other way about, we believe that not only the terminology but the present state of flow measurement and control would be different.

(e) Industrial

Critical examination of the foregoing, from the industrial viewpoint, leads to a definition that takes in all devices called current meters in the field of Instrumentation and excludes all others: *A current meter is one of which the primary element translates the linear speed of a fluid into rotational speed, while the secondary device measures this speed—intermittently by counting or continuously by any suitable tachometric means.* We say "speed," not "motion," because industrial applications, in general, call for indications of instantaneous values and for records of variations more frequently than for integrated readings.

2. Types of Current Meters

The A.S.M.E. Fluid Meter Committee divides the current class into four types:

2.11 Propeller 2.12 Anemometer 2.13 Turbine 2.14 Helical

but has never defined them in any of the successive editions of its Report. We doubt that they can be defined, without altering accepted meanings, so that each type will be distinct. A helicoidal propeller anemometer, *ex vi termini*, would belong to three of the four types. In a recent (Aug. 1932) private communication to the author, one member of the Committee states:

. . . The trouble seems to be that accepted usages have arisen without thought of consistency, *e. g.* an anemometer may have a helical propeller, or, more accurately, turbine—using these words in their broader sense. My own off-hand definitions are as follows:

Anemometer—A rotary device, totally immersed in an unconfined fluid, and having a speed proportional to that of the fluid. This device is generally equipped only with a counter so that it is necessary to obtain the speed by counting the revolutions over a given period, using a stop-watch preferably. *Turbine*—A turbine meter has the impeller mounted, turbine-fashion, in a casing so that the fluid is guided into the impeller. The flow is usually radial rather than axial. *Helical*—A helical meter has a relatively long screw impeller with guided axial flow. *Propeller*—A propeller-type meter has a propeller-shaped impeller, resembling the conventional familiar marine or airplane propeller. These propellers are usually mounted rigidly in fixed relation to the walls of a conduit, or channel, and their indications used in giving actual volume-rate data.

A canvass of all other committeemen would probably disclose a tendency to drop this scheme and these names. Anyway we venture to depart, just this once, from the committee's scheme.* Fig. 24-1 shows a few meters and some of the type designations are tabulated below.

Various interesting designations appear in the quotations in §1, other in §3, and further extracts from the literature need not be adduced to show the rationality of a three-type scheme based not only on primary elements but also on flow direction and stream action. It makes it convenient, moreover, to take up the characteristics.

*No need, however, to re-open the whole question: underlying it is the generally accepted scheme that fluid meters of one class are divided into types corresponding to their primary elements. Classes are in almost every respect mutually exclusive; types are less so, but they should at least be distinct, for otherwise they are not types but variants or what throughout this Manual we call "forms" or "models" regardless of the schemes of terminology employed by other writers on measurement. Moreover, when it comes to current meters, one must concede that the highest authorities are found in the civil engineering profession—in which we include the U. S. Geological Survey and Department of Agriculture (both large users) and the Nat'l Bureau of Standards (which rates the meters).

MANUFACTURERS' LITERATURE

In this department we list each month the printed matter issued by manufacturers. Unless otherwise noted, any of the items listed may be secured free upon application to the issuing firm. Manufacturers who have not yet sent in their printed matter are invited to do so.

249 Sperryscope. Among the articles listed in the July, 1932, issue of this publication are the following: "Achievement"; "A New Steering System"; "Development of the High-Intensity Arc," etc. Sperry Gyroscope Co., Inc., Brooklyn, N. Y.

250 Temperature Controllers. Bulletin No. 177 contains interesting and valuable engineering information on Temperature Control. It has 48 well illustrated pages describing the operation and construction of temperature controllers and their uses in industrial processes. The Foxboro Company, Foxboro, Mass.

251 Concrete Testing Laboratory Convenience. 4-page bulletin describes CYL-O-DON molds, cardboard forms for molding concrete cylinders used for strength tests. Standard Concrete Testing Apparatus Co., Washington, D. C.

252 Resistors. Bulletin No. 125 on Hi-Meg resistors, 5 to 5000 megohms. Shallcross Mfg. Co., Collingdale, Pa.

253 Bakelite Review. The July number describes many applications in various industries. Bakelite Corp., New York.

254 Johansson Sine Bar. A comprehensive table of constants for its use when set at any given angle. Ford Motor Co., Johansson Div., Dearborn, Mich.

255 Smoke Recorder. Folder on the application for this purpose of the Micromax potentiometer. Leeds & Northrup Co., Philadelphia.

256 Telephoto. Folder on caesium argon type photoelectric cells. Telephoto and Television Corp., New York.

257 Visual Frequency Indicator. Folder contains construction data and operating instructions on Type FI-1 outfit. Doolittle & Falknor, Inc., Chicago.

258 Bu. of Stds. Type Prover for Testing Machines. Folder on ring form checking instruments in capacities to 300,000 lbs. Morehouse Machine Co., York, Pa.

259 Park's Parables. The July number discusses bodily comfort and health with regard to humidity. Parks-Cramer Co., Fitchburg, Mass.

260 Current Meter. 16-page bulletin (English) gives instructions for use of Ottmeter V for water flow. A. Ott, Kempten, Bavaria.

261 Water Level Gage. Bulletin (Cat. Ref. 20) on Teledep boiler water level gage. Dobbie McInnes & Clyde, Ltd., Glasgow.

262 Photoelectric Tubes. Bulletin B on "Speed" Foto-Lectric tubes, "Lyle Engineered." Cable Radio Tube Corp., Brooklyn, N. Y.

263 Electron Tubes in Industry. Reprint of a paper by W. R. King. 12 pages. General Electric Co., Schenectady, N. Y.

264 Current Meters. Reprint of article by S. J. Bitterli in Power. A. Ott, Kempten, Bavaria.

265 Separator. "DriAir" separators for compressed air lines described in Bulletin DA. New Jersey Meter Co., Plainfield, N. J.

266 Flow Indicator with Signal Device. Bulletin FS describes "FloSig" instrument which opens or closes circuit at given rate of flow. New Jersey Meter Co., Plainfield, N. J.

267 Circuit Breakers. Bulletin C-1939 describes line of "De-Ion" circuit breakers which open at 1700% overload without a flash. Westinghouse Elec. & Mfg. Co., E. Pittsburgh, Pa.

268 Circuit Breakers. Bulletin C-1937 on Type AB "De-Ion" low voltage circuit-breakers. Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

269 Radio Tube Checker. Leaflet on Model H-32 outfit. Franklin Radio Corp., Dayton, Ohio.

270 Hydrometer. Leaflet on boiler water concentration hydrometer. Dearborn Chemical Co., Chicago.

271 Automatic Gas Analysis. 16-page Catalog No. 1025 on TAG-Mono line of indicator-recorders for CO, CO_2, CO + H_2, etc. C. J. Tagliabue Mfg. Co., Brooklyn, N. Y.

272 Thermostat. Bulletin No. 107 on No. 11 room temperature thermostat. United Electric Controls Co., Boston, Mass.

273 Fuel Governor. Leaflet on engine governor with remote-setting for speed. The Pickering Governor Co., Portland, Conn.

274 Microscope. Bulletin D-125 on improved wide field binocular microscope. Bausch & Lomb Optical Co., Rochester, N. Y.

275 Scopometer. Bulletin D-205 on photoelectric instrument which makes turbidimetric and colorimetric measurements with greater speed. Bausch & Lomb Optical Co., Rochester, N. Y.

276 Small Motors. 12-page bulletin on fractional h.p. single-phase motors and on buffers and grinders. Sunlight Electrical Mfg. Co., Warren, Ohio.

277 Manometers, etc. Small leaflet catalogs several pressure instruments, mentions others. Refinery Supply Co., Tulsa, Okla.

278 Liquid Level Control. 8-page Bulletin No. 181 on the Level Stabilog which controls flow and eliminates surges. Foxboro Co., Foxboro, Mass.

279 Control Valves, etc. Bulletin No. 23 on Hornung Master Control Valve, also describes thermostats. Central Heat Appliances, Chicago.

280 Humidity Recorder. Bulletin No. 413 describes "Humidigraph" single-pen relative humidity recorder and combined recorder with temperature pen. The Bristol Co., Waterbury, Conn.

281 Cycle Controllers. Bulletin No. 386-A announces new types of single- and multiple-cam process cycle controllers. The Bristol Co., Waterbury, Conn.

282 Electrical Temperature Instruments. 28-page Bulletin No. 871 (Power Plant Series) on temperature measurements in generators, transformers and cable systems. Revised edition of this little treatise on resistance and thermocouple methods. Leeds & Northrup Co., Philadelphia.

283 Tri-dimensional Vibrograph. 4-page bulletin on Shrader system vibration recorder. Vibration Specialty Co., Philadelphia.

284 Rubber Testing Instruments. 4-page Bulletin No. 1400 fully describes Firestone Penetrometer, etc. American Instrument Co., Washington, D. C.

285 Instrument Service. 4-page bulletin outlines scope of repair and rebuilding service on all makes and types. Instrument Service Co., Hoboken, N. J.

286 Temperature & Pressure Control. Bulletin DDD on 4 new models of motorized draft and temperature regulators. Defender Automatic Regulator Co., St. Louis, Mo.

287 Electric Controllers. 4-page Bulletin No. 106 on controllers for temperature, water level, pressure, etc. United Controls Co., Boston, Mass.

288 Thermostats & Switches. Leaflet entitled "Control Devices for Heat—Light." The Hart Mfg. Co., Hartford, Conn.

289 Laboratory Apparatus. 2-page Bulletin No. 149A on Brevoort's Julius Suspension; 2-page Bulletin No. 152 on clamps and stands; 4-page Bulletin No. 154 on galvanometer scale, lamp, telescope, photo-electric relays, stands. G-M Laboratories, Inc., Chicago.

290 Resistors. 4-page Bulletin No. 151 on slide wire rheostats with micro-adjustors. G-M Laboratories, Inc., Chicago.

291 Photoelectric Relays. 4-page Bulletin No. 150 on several types of industrial and scientific relays, housings and accessories. G-M Laboratories, Inc., Chicago.

292 D. C. Power Supply Unit. 2-page Bulletin No. 147 on controllable variable source of d.c. for laboratory use. G-M Laboratories, Inc., Chicago.

293 Electric Heater Units. 2-page Leaflet No. TB-30 on immersion units. Harold E. Trent Co., Philadelphia.

294 Mill Motor Starters. Leaflet No. L-20554 on heavy duty "Timestarters." Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

(b) By Fields of Application

The foregoing does not preclude dividing current meters according to their fields of application—into three non-overlapping groups:

(1) *Anemometers,* including aircraft logs and air speed indicators of the current meter class;

(2) *Stream-gaging* or hydrographic current meters, including also the usual form of ship logs;

(3) *Closed* current meters or *Turbine Meters.* (The great majority are of the turbine *type* but a few have a helical or helicoidal primary element. It is not incorrect to call them all turbine meters. Thus the Woltman closed current meter is a turbine meter of the screw type.)

In connection with these three divisions of "current metering," note that there are anemometric and open-stream flow measuring instruments that are not current meters.

(c) By Secondary Devices

Of considerable importance to users are the characteristics of the secondary elements of current meters. These may be divided, as is done with other classes of inferential fluid meters, into indicating, recording, integrating or registering, and combination. Counting and graphic registering instruments outnumber all others in the field of industrial current meters and may be had with any desired type of primary element. Velocity indicators and recorders are scarcer and unless the application permits the use of a scientific instrument the choice of primary elements is limited.

It is of interest, also, to know the advantages and shortcomings of the various electrical and mechanical systems employed in the registers and in the other instruments. These need not be classified formally into definite types, and will simply be discussed as they come up under commercial current meter descriptions in the concluding sections of this chapter.

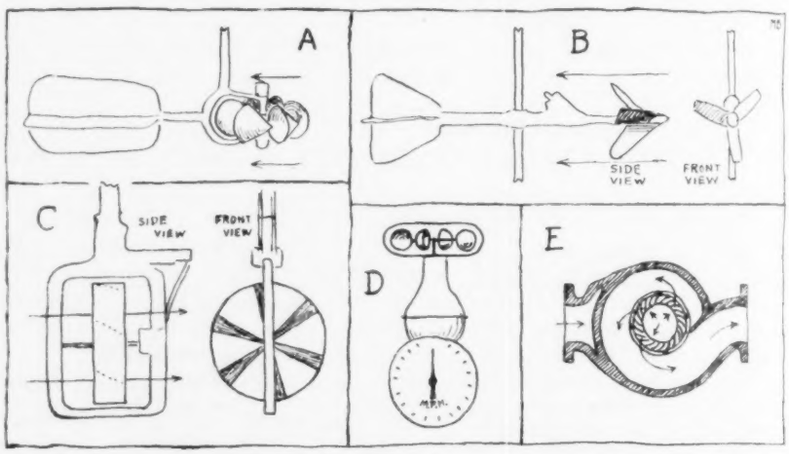

Fig. 24-1. Some Types and Forms of Current Meters (Roughly Sketched)

Sketch	Fluid Usually Metered	Nature of Stream	Flow	TYPE DESIGNATION			
				Herein Adopted	Others		
					By Shape	By Axis of Rotor	By Action
A	Water	Open	Transverse	**Cup**	Anemometer Turbine Windmill	Vertical axis	Differential
B	Water	Open	Axial	**Screw**	Propeller Helical Helicoidal	Horizontal axis	Direct Positive
C	Water	Open	Axial	**Screw**[1]	Fan Propeller Helical Turbine	Horizontal axis	Direct Positive
C[2]	Air, Gas, Water, etc.	In Pipe	Axial	**Screw**[1]	Fan Propeller Helical Turbine	Horizontal axis	Direct Positive
D	Air	Unconfined	Transverse	**Cup**	Anemometer Turbine Windmill	Vertical axis	Differential
E	Hot Water	In Pipe	Radial	**Turbine**	Rotary		Velocity Positive

[1] "Shrouded" screw. Shrouding is not a type: it is a *feature.*
[2] Not the instrument sketched at C but modification of that type.

3. General Characteristics

(a) A.S.M.E. Fluid Meter Committee's Discussion*

A free balloon in a steady wind takes up the velocity of the air about it, no matter what the density and viscosity of the air may be. But in every mechanical meter there is, unavoidably, some friction at the bearings of the rotor and in the secondary mechanism which counts the revolutions, so that the motion of the rotor is not quite free but slightly retarded, as when a balloon is trailing a rope along the ground. The distance the fluid moves past the rotor is a little greater than the product of pitch by number of turns. The difference may be called the slip, and its ratio to the travel of the fluid, the slip ratio. If there were no friction the slip ratio would be zero, while if the friction increases so as finally to stop the rotation altogether the slip ratio increases to unity or 100 per cent.

If the slip ratio were constant, it might be allowed for by a constant multiplier embodied in the secondary mechanism so that the meter would read correctly in spite of the slip. In practice, however, the resistance to rotation is usually due largely to solid friction and does not increase so fast as the speed, whereas the driving torque due to impact of the fluid on the rotor increases nearly as the square of the speed; and it follows from this relation that the frictional torque decreases, and the slip ratio therefore also decreases, with increase of speed. Current meters thus have a tendency to read low at low speeds and they should not be relied on at speeds below those for which they were designed and at which their accuracy may be entirely satisfactory. For example, the ordinary Robinson cup anemometer does not start at all till the wind has attained a certain minimum speed, which is usually of the order of 1 mile per hour.

If there were no resistance to rotation, the fluid would do no work and exert no force. The action of the meter would then be purely kinematic and the density of the fluid would be a matter of complete indifference. But when there is a resistance to be overcome by the impact of the fluid on the rotor, the density of the fluid is an essential element in the behavior of the meter. The greater the density of the fluid the less will be the slip caused by a given resistance. Hence while the so-called "air meters"—merely small fans with revolution counters—have to be made with the utmost attention to reducing friction, a screw current meter for use in a river may have vastly more frictional resistance before any sensible error is introduced.

At very low speeds, for very small rotors, or in very viscous liquids, viscosity as well as density enters into the action of the fluid on the rotor. But in the practical range of speeds for which a meter is designed, and in a fluid to which it is adapted, its operation—like the motion of a free balloon in a steady wind—may be regarded as sensibly independent of moderate variations in the properties of the fluid.

(b) Open-Stream Types

There are two types of these (See § 2). The leading American designer of one type is Carl H. Au; of the other, E. J. Hoff. Each has contributed a discussion covering *both* types—

By CARL H. AU

The use of a current meter for general stream gaging gives results that are positive rather than comparative as in the case of weirs. In the hands of an experienced stream gager it gives results more accurate than any known method. For power plant water measurements it is often the only method possible and gives results as accurate as other methods except under very adverse conditions.

The great advantage in using a current meter is that it gives immediate and accurate results at small cost, mainly because it does not require costly and time consuming preparation for a measurement.

Generally speaking, both types of meters, differential and direct action, can be made so that velocities as low as 0.05 ft. per sec. can be measured. Velocities as low as this, however, cannot be accurately measured as yet under conditions of normal field use. Under ordinary conditions a meter is considered in good shape if it can be depended upon to give true results when measuring velocities as low as 0.15 ft. per sec. Velocities as high as 15 ft. and higher, per sec., are being measured.

The friction of a current meter may be divided into two parts, mechanical friction of the metallic parts against one another, and the friction of the water preventing rotation of the wheel. For velocities below 0.7 ft. for a differential meter, the mechanical friction seriously influences the rating of a meter and its "consistency, therefore a meter must be in perfect shape, particularly the lower pivot and pivot bearing if it is to be used for low velocities. For velocities of 1½ ft. per sec., the mechanical friction has little effect on the rating of a differential meter, in fact for velocities above this value, a differential meter will continue to rate better the more it is used; that is, the revolutions will gradu-

*This admirably written discussion has appeared unamended in successive editions of the Report since 1924.

295 Portable Recording Thermometer. Leaflet on a miniature recorder for refrigerators, etc. Practical Instrument Co., Chicago.

296 Oil Testing Thermometers and Hydrometers. 4-page bulletin on latest A.P.I. and A.S.T.M. instruments. F. V. Hiergesell Mfg. Co., New York City.

297 Temperature and Water Level Recorder. 4-page Bulletin No. 388 on recorder for laundry industry. The Bristol Co., Waterbury, Conn.

298 Crane Scales. 4-page Bulletin No. A-1 on dial indicating suspension scales. The Kron Co., Bridgeport, Conn.

299 Tycos Rochester. The July issue has articles on preservation of Tycos standards of accuracy, observing earth's magnetism, barometer and thermometer in modern home, nautical and pocket compasses, etc. Taylor Instrument Companies, Rochester, N. Y.

300 Transmission Line Protection. 4-page bulletin "Leaflet 20547" on "Delon" protector for line insulator protection. Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

301 Transformers. 4-page Leaflet 20550 describes Inertaire equipment for preserving insulation and oil. Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

302 Transformer Tap Changers. 4-page Leaflet 20549 covers Type UT load tap changer. Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

303 All-weather Sextant. Leaflet describes new instrument using infra-red solar radiation. Macneil Instrument Corp., New York.

304 Gas Protector Hood. 4-page bulletin covers device preventing corrosive gases entering measuring chambers. H. A. Brassert & Co., Chicago.

305 Stress-strain Recorder. 4-page bulletin A-129 fully describes extensometer and recording mechanism. Baldwin-Southwark Corp., Philadelphia.

306 Noise Meter. 4-page bulletin GEA-1624, also two leaflets, on portable (in 4 cases) equipment for measuring loudness and frequency composition of noise. General Electric Co., Schenectady, N. Y.

307 Wind Measuring Station. 4-page bulletin describes outfit comprising velocity and direction recorder with complete accessories. Amer. Askania Corp., Chicago.

INSTRUMENTS, 3619 Forbes St., Pittsburgh, Pa.

Please have me supplied with a copy of each piece of Manufacturers' Literature listed below:

.....

.....

Name.....

Position.....

Firm.....

Street and No.....

City..... State.....

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Combining in one Instrument for one Price
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THE MICRO-CHEMICAL BALANCE
THE ASSAY BALANCE
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The
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Makers
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INSTRUMENTS BOOK SHELF

The books reviewed in this section can be supplied by the Instruments Publishing Company.

Advanced Electrical Measurements. WILLIAM R. SMYTHE AND WALTER C. MICHELS. D. Van Nostrand Company, Inc., New York, 1932. Cloth, 8¾x5¾ inches, 240 pages. Price $3.00.

Though there are many texts available on electrical measurements, this one embodies several features, making it particularly valuable as a college laboratory manual in those courses which train the student in the use of electrical instruments and measurement methods.

The authors have shown excellent judgment in selecting, from a wide field of electrical measurements, those experiments which are the most beneficial to the student. Experiments on measurement of resistance, potential, current, quantity of electricity, vacuum tubes, amplifiers, alternating currents, bridges, etc., make up a large part of the text. Among these are measurements on important modern subjects such as the four-electrode amplifying tube and the short wave oscillator. Probably the most notable feature of the text is the inclusion of measurements by electrical methods of quantities primarily non-electrical in nature, such as temperature and radiation, thus indicating vividly to the student the significance of electrical measuring methods to such an important and growing field.

The same general treatment of the subject matter is used throughout the book; first the theory involved is given and then the experimental directions. Here it must be stated that the directions are so clear and explicit that the student should be able to perform the experiments with little help from the instructor. A full description of the apparatus used—which incidentally is of standard manufacture and available in most college laboratories—as well as the wiring diagrams is given, so that the student is fully acquainted with every detail of the experiment.

It is evident that the authors, in compiling this book, have been guided to a large extent by the experience they have gained by teaching a course in electrical measurements. They have produced a laboratory manual which can be used very effectively in similar courses given in other institutions.—N. Nazar. (4.1) B

Braun Cathode Ray Tubes and Their Use (Braunsche Kathodenstrahlröhren und ihre Anwendung). E. ALBETRI. Julius Springer, Berlin, 1932. Cloth, 9½ x 6½ inches, 214 pages. Price 22.20 marks.

The first part of the book gives a historical review of the development of cathode-ray oscillographs from 1859 up to the present time. Written by a member of the German Patent Office, this part of the book is a very valuable contribution to priority.

The following part of the book deals with the characteristics of cathode rays and shows how the physical problems involved determine the design of cathode-ray oscillographs. Very valuable information is given for the design of high-voltage oscillographs. The recent development, however, of low-voltage cathode-ray tubes as found in the United States at present, is not included.

The next part of the book deals with the uses of cathode-ray oscillographs and their application for measuring purposes. Valuable information on photographic technique is given. Here again, however, high-voltage oscillographs are dealt with chiefly, whereas methods of light control and other problems involved in television are just mentioned.

One of the most valuable parts of the book is the very extensive and carefully compiled bibliography.—Eduard Karplus. (5.4) B

(Continued on Page A13)

ally increase for the same velocity when rating from time to time, this being true regardless of the condition of the meter as long as it is useful for measurements at all.

When used in the field, the differential meter turns the same number of revolutions regardless of the direction of the current,* therefore, if the flow is not at right angles to the measuring section, a correction for this must be made. This is true also of the direct action meter if it is suspended from a cable, not if rod suspension is used.

In Europe the meters used are generally of the direct action type. In this country the differential meter is the one used by the majority of engineers. There is considerable dissention between European and American engineers as to which meter is the most accurate and useful and many very elaborate and painstaking laboratory tests have been made to determine which meter is superior. Owing to the difficulty in comparing the two types under actual field conditions with a standard method of measurement, which is above suspicion, the engineers using the differential meter are not convinced that the direct action meter is superior when used as a meter for general stream gaging.

It may be conceded, theoretically speaking, that the differential meter over-registers because a current striking it from any direction produces the same effect as if the current were head-on. Practically, this has not been proved conclusively even in numerous and most exhaustive laboratory tests, much less under field conditions.

Defenders of the direct action meter constantly mention the fact that this meter only gives the true component of the current perpendicular to the section, especially in turbulent water. If this is so it is true only if the meter is held rigidly perpendicular to the section, that is, if rod suspension is used. In most comparative tests there is no mention of method of suspension, which latter of course, changes the conditions of comparison completely. It certainly is not true under cable suspension, and as direct action meters are always furnished with a tail it seems reasonable to suppose that they will set themselves in line with the current, regardless of direction.

It is generally assumed that an over-hung meter of the direct action type is better for use in streams filled with floating leaves and grass than a differential meter, but this also has not been proved conclusively. For streams with frazil ice, the direct action meter is much superior, as the buckets of the differential meter fill with ice.

As far as service is concerned, differential meters being mostly made without ball-bearings, the meter is easily taken apart and cleaned, replacement of parts is easy and it has been found that small changes of shape of buckets due to impact does not change its rating. As a universal meter for general stream gaging where cable measurements are just as important as rod measurements, satisfying the conditions laid down for a good meter, the differential meter has not been excelled.

By E. J. HOFF

How do the two meter types, the vertical axis meter with its cup turbine and the horizontal axis meter with its propeller, meet the stream forces?

The vertical axis meter presents a revolving turbine to the flow. While moderate in size it is complicated in form and encourages the formation of eddies. The arrangement of the cups about the vertical shaft causes the turbine to disregard flow directions; thus the meter is actuated by the sum of forces instead of by their forward component; hence the turbine meter overrates. Disregard of flow direction also disqualifies the meter for the vertical integration method of stream gaging. The water that reaches the turbine and causes its rotation is not readily discharged, as evidenced by the depressed slope of the meter's rating curve. A new condition in flow direction is brought about as the stream filaments approach the rotating turbine, one half of which is, by its motion, favorable to the flow, the other half unfavorable—since this moves against the flow—and its flow retardation is much greater than that at the favorable half. Being very sensitive in finding the least obstruction, the stream lines switch over from the negative to the positive side, thus creating a decided over-balance in kinetic energy which may account for the super-sensitiveness of cup meters. (The correctness or value of such meter action, however, is doubtful in low velocities when the unstable flow retardation and eddies exert their influences to the fullest extent.)

The horizontal axis meter, with its propeller in normal position toward the stream flow, meets the velocity forces squarely, the resulting rotation discharges the water with least retardation and with least deviation of flow direction; and the formation of eddies is confined to a small area unless the meter body and its support should be of dimensions exceeding that of the rotor hub, in which case eddy influences will react upon the rotation and lower it. Propellers of helical form do not discharge the water readily. This fact is vividly illustrated in the efficiency curve of such meters. Plane-faced propellers, their blades set at a convenient pitch, rotate at maximum speed when flow directions are parallel with the meter axis and do not rotate when forces approach at an angle of 90 degrees. Such propellers are actuated by the forward component of velocity forces. Reliable meter work is obtainable by the vertical integration method of stream gaging.

In very low velocities, the reliability of meter action of all meters regardless of type, is questionable, being the result of a balance of opposing forces (inertia against velocity forces influenced by eddies). Horizontal axis meters seem sluggish in action but rally promptly to *reliable* service at an unusually low velocity.

Flow retardation requires personal effort in meter operation in holding the meter in position, and the less there is of it, the better the meter work is likely to be.

The fact that the *best* meter produces highest meter action by least flow disturbance may aid in the judging of meters. One can see if meter form and size comply with the rules of least flow disturbance, while the rating and efficiency curves prove by their normalcy the quality of meter action.

Being mechanical devices which are exposed to field use and abuse, current meters must be strong, yet delicate in action so that their rotors will be under complete control of the everchanging stream flow. In current meter development some desirable features are not attainable without curtailing other essentials. This makes the meter appear to be a compromise between theory, practicability and serviceability. It most likely accounts for the varying opinions of interested engineers—a fact that points strongly to the necessity of an official investigation to settle the controversy.

*Horizontal current, and axis of meter perfectly vertical. Inclined currents, as for example over a submerged rock, may cause errors.—M.F.B.

NEW INSTRUMENTS

Recently Developed by Manufacturers

Write Information Section, Instruments Publishing Company, for additional Information.

Standard Model Potentiometer

Hellige, Inc.

WHILE embodying some drastic improvements in its design, the new Hellige Standard Model potentiometer is not a "trick" instrument, but built on the orthodox plan of Poggendorf. It is specially intended for pH determinations with utmost convenience and speed and can be used with equal facility for electrometric titrations, either acid-base or oxidation-reduction, the same as any other instrument of its kind. In spite of the fact that it carries no millivolt calibration, if for any reason indications in volts are required, these are readily calculated from the pH readings by a reversal of the procedure necessary with ordinary potentiometers reading in volts and requiring conversion to pH values.

An outstanding novel feature is the counting device which permits direct reading of the pH values, without calculations or reference to a table after the current has been balanced. A definite length of the main resistance wire on the drum, traversed by the contactor as the drum is revolved to balance the electrode potential against that of the electrical system of the potentiometer, corresponds to a definite pH interval. The latter is indicated by dials revolving with the motion of the drum. The system of dials, visible through a window, is geared to the drum and a lever at the left-hand side of the potentiometer housing is provided for connecting or disconnecting the device. This arrangement is similar to that on the familiar calculating machine and shows at a glance in plain side-by-side figures the pH values in units and fractions thereof, to the second decimal place. Through interpolation between two adjacent figures on the dial, each indicating 1/100 of a pH unit, readings of 0.005 pH can easily be made and smaller fractions may be judged with fair accuracy. This exclusive feature adapts the apparatus ideally for plant use and quick routine work.

Among other important improvements in design is the automatic compensation of slight variations from theoretical values for electrode potentials, due to individual characteristics of electrodes, and slight temperature differences which might not be noticed by the operator. This feature is secured by a test of the pH of a standard buffer solution, the accurate value of which is known, which is standard procedure in all careful work. With other potentiometers, the proper correction must be noted and applied in calculating the results; with the Hellige Standard it is set on the instrument and applied automatically.

All important working parts are enclosed in a metal case finished in crystal black. Thus they are shielded from stray electric currents and entirely protected from dust and corrosive fumes. The case is 10½"x6½"x9". The total height of the instrument, including the capillary electrometer as illustrated, is 12".

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Askania Gas Protector Hood

H. A. Brassert & Co.

A GREAT advantage of Askania measuring instruments and regulators is the use of diaphragms to determine pressures. The volume filled up in case of pressure changes is small compared with the corresponding volume in instruments of the submerged bell type, where the range from minimum to maximum pressure corresponds to a volume as high as 100 cu. in. (This means about 20 yards of gas travel in a ½" pipe, and results in lag in indication as well as clogged impulse lines.) The Askania diaphragms have a filling volume of less than one cubic inch. Therefore, no actual flow takes place but merely transmission of pressure, and under ordinary circumstances, no dust can enter the measuring chamber.

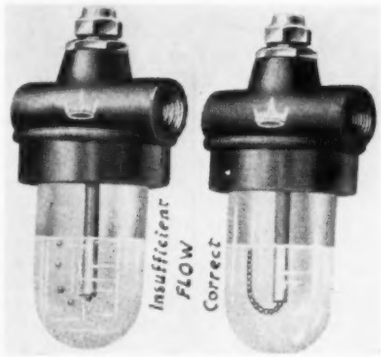


Fig. 1

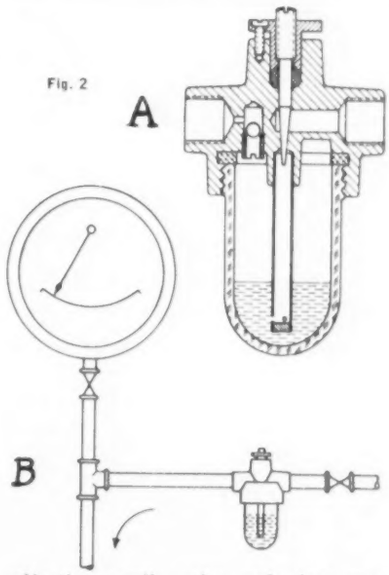
A further protection, the Askania Gas Protector Hood, prevents the entrance of corrosive gases or condensate within the measuring chamber. It accomplishes this by building up a cushion of neutral gases without affecting the accuracy of the pressure reading. It should be applied, therefore, whenever producer gas, or other uncleaned gas or chemically reacting media are to be measured.

The instrument comprises a needle valve and a glass container partly filled with water or oil. A small amount of neutral gas (air, nitrogen) is allowed to enter the impulse line. By a steady flow of protecting gas in the direction of the point where the impulse is taken, even the diffusion of the two gases is prevented. The air consumption does not exceed two thirds of a cubic foot per hour. Even at low pressure, the accuracy of the reading is not affected.

The amount of air going through the valve can be set by a screw at the top of the hood, and can be determined by watching the air bubbles rise in the liquid. (See Fig. 1.)

Fig. 2A is a cross section showing protecting gas inlet, protecting gas outlet, adjusting needle valve and glass container. Fig. 2B is an installation in connection with a pressure gage.

Fig. 2



The Gas Protector Hood should be installed close to the regulator or measuring instrument by means of a "T" connection. One branch goes to the diaphragm chamber, another to the impulse line and the third to the protecting gas supply. This last connection is a ⅜" pipe.

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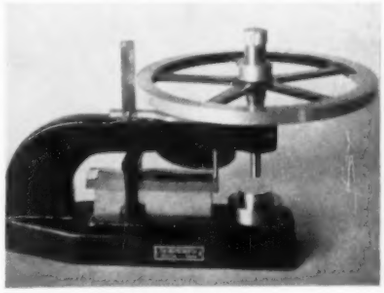
New Van Keuren Light Wave Micrometer

The Van Keuren Company

AN extremely accurate bench micrometer, using light waves as a very sensitive indicator of contact and pressure of measurement, has a measuring wheel graduated in units of 0.0001 in. permitting readings estimated to 0.00001 in. A movable index is provided for a quick setting of the zero reading. The optical flat is held in contact with the 3-in. steel flat with a spring pressure and is connected with a tension rod to the arm supporting the micrometer. Thus the



slightest bending of the micrometer arm is detected by a movement of the light wave interference bands.

In operation, the micrometer is turned to a zero position with a movement of one, two, three or more bands depending on the measuring pressure desired. The index is set to zero and the measurement taken with the same movement of interference bands as used for the zero reading. While the instrument is operated and read as a micrometer, slight variations in size due to taper, out of roundness or other cause, can be determined from the movement of the light wave bands.

Since the micrometer is provided with two flat parallel measuring faces and can be used at any desired measuring pressure, it is suitable for a wide variety of uses, such as measuring paper, rubber or soft materials, as well as for the measurement of gages and for general shop use.

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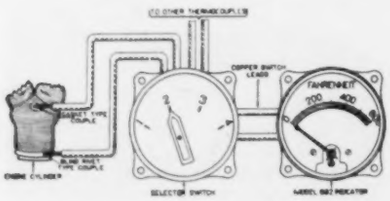
New Aircraft Cylinder Temperature Indicator

Weston Electrical Instrument Corp.

ONE of the first successful aircraft electrical instruments, the Weston Aircraft Tachometer, has now been followed by a cylinder temperature indicator of the thermocouple type, known as the Model 602. The instrument is built into a standard 2¾ in. aircraft case, has the usual black dial with luminous figures, is calibrated 0-600°F. and is effectively shielded for the protection of the magnetic compass. Its automatic cold-end compensation provides accurate direct reading of the pointer without recourse to calculation. Almost complete compensation is also provided to reduce its own temperature coefficient to a negligible minimum. As the scale reading starts at zero degrees Fahrenheit and not at some higher figure above normal room temperature, it is an easy matter to check the pointer setting at any time if it is desired to do so by simply disconnecting one lead wire from the binding post and comparing the reading with an accurate thermometer: the two should agree as the indicator will act as an ordinary thermometer when disconnected. The indicator can be adjusted for use with copper-constantan or iron-constantan thermocouples, although the former is preferable and is adopted as standard. All standard indicators are adjusted for use with an external circuit of 2.0 ohms resistance, in which case they all have the desirable feature of being interchangeable.

The thermocouples, of unique design, combine inherent strength with ease of installation. The Gasket type is supplied for spark plug mounting; the special Weston Blind Rivet type is designed for cylinder bases or whenever it is desired to embed the thermocouple into the metal.

The Weston copper-constantan thermocouple flexible leads are supplied in various standard lengths, all having the same resistance, thereby making them interchangeable. They have suitable union type terminals at the thermocouple end, arranged so that correct polarity is assured. The indicator may be operated from any number of thermocouples by the use of a suitable double pole selector switch which can also be provided.



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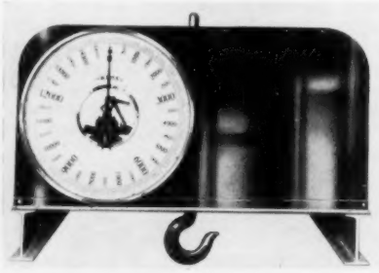
Crane Scales Eliminate Extra Handling

The Kron Co.

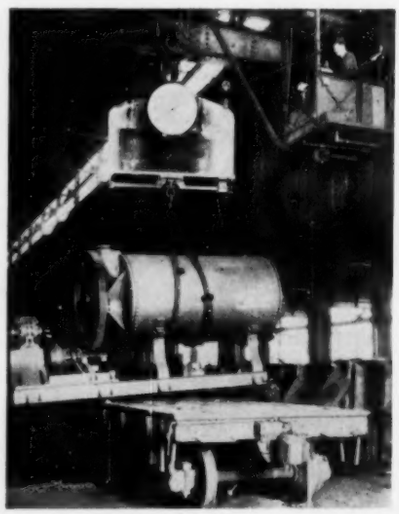
ALTHOUGH the Kron is said to be the pioneer springless industrial scale, placed on the market in 1908, new designs of crane scales together with a new dial mechanism lead the makers to claim that their products are the most up-to-date. Two designs of crane scales are announced, a "regular" (shown in use) and a "low head" (shown in Fig. 2). Each is made in ten capacities, from 750 lbs. to 50,000 lbs.



The Kron crane scale is attached anywhere on the suspended or lifting line—be it a cable, a chain, a rope or a rod. Under no condition can the load drop through any breakage or failure on the part of the weighing mechanism. The frame is capable of holding up a load many times greater than any that may be placed on the lifting mechanism. Tare beam is provided inside the frame to balance off sling chains or cables, which allows obtaining the net reading on the dial. Either ball bearing swivel or rigid hook, or eye bolt can be furnished.

Among the features of the Kron dial head and mechanism are the following:

One point cam adjustment—entirely unique—permits accurate adjustment at every graduation on the dial. No springs. Specially designed anti-friction bearings. Dial head mounted on swivel for reading from any angle. Vibrating of dial pointer overcome by the new patented non-vibrating sector. Dials can be furnished in 20 to 36 in. sizes with either single or double face. Interchangeable dial mechanism in all scales regardless of capacity or type. Auxiliary sector compensates for wear and absorbs all possible backlash. Instantaneous, accurate reading due to unusual clearness of dial, indicated by knife blade pointer. Oil seal, preventing dust from working its way up to the indicating mechanism. Dial head sealed against dust and moisture. Load pressure remains constant over center of the bearings at all times whether the pointer indicates zero or full capacity. Open face dial permitting unobstructed view of working mechanism at all times. Not affected by overloading. Correct weight indication even though scale is out of level.



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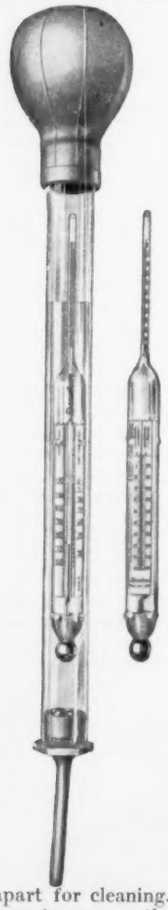
New Improved Dearborn Concentration Hydrometer

Dearborn Chemical Company

AN IMPROVED concentration hydrometer, for determining total dissolved solids in boiler waters, has several distinctive points of difference from other instruments on the market. This new instrument consists of but one float and one tube, all scales being inclosed in the float. This feature is unique and patent to cover it has been applied for.



The hydrometer is quick acting because of a mercury thermometer being used, and the space between the tube and the float permits the float to rise more rapidly. The float is provided with substantial projecting knobs to prevent friction of float against tube.

The novel method of construction has many advantages. The instrument is very compact, requires no special care in operation and will stand rough handling because of the single tube design. Danger of float stem breakage is eliminated. The operation is so simple that readings can be taken in the cab of a moving locomotive.

The instrument may be easily taken apart for cleaning. It is never necessary to remove the rubber bulb—float is withdrawn from the jar or tube by removing the lower rubber fitting. The outer rim of this fitting is hexagonal in shape which prevents instrument from rolling when at rest.

The float can be removed from the assembled instrument and operated in a separate container if desired.

Stress-Strain Recorder

Baldwin-Southwark Corp.

As engineering technique advances, requirements point more and more to the necessity for an autographic record of the stress and of the strain, which shall be as accurate as could be plotted manually from the stress-and-strain readings. The Southwark-Emery Stress-Strain Recorder draws a stress-strain curve as accurately as could possibly be plotted by hand, from readings of the best extensometer used in the best possible testing machine. Inherently, the extensometer control exceeds the precision of the usual indicating extensometers and the curve grows from countless automatically plotted line segments, instead of a few points widely spaced as in hand plotting.

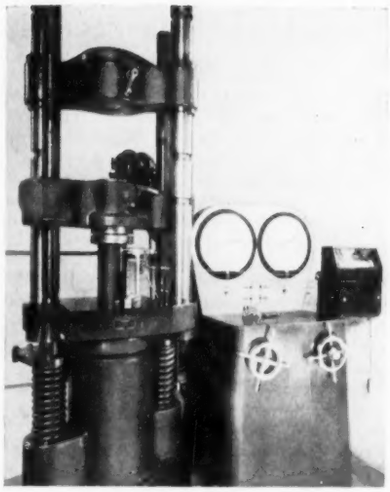
The load values are accurate to the same degree as the Emery dial readings. A three-dial testing machine is paralleled by three widely spaced recording ranges, which extend the precision of the instrument equally to all load ranges.

The strain values plotted by the recorder are accurate to the same degree as the average of two Huggenberger Tensometer readings, mounted on two sides of the specimen bar (Huggenberger ratio 1000:1). These latter indicate directly to 0.00001 inch through lever multiplication and are used for the most precise readings of elastic deformation.

For any material, ferrous or non-ferrous, for alloy steels, heat treated, normalized or annealed, the values of Young's modulus of elasticity and of the limit of proportionality may be determined with precision, as well as those of the elastic limit and the yield strength.

The value of yield strength appears whether the material presents a curve of the "knee" type or a curve of gradual curvature (relatively large radius) at this point. There is no form of curve on which these values are not shown clearly. The curve avails itself of the entire 9½x13-inch chart area, so that the determination of precise values of all critical points is possible. The record is not usually carried beyond the yield point, because of the limitation of chart size, but if a smaller scale for the elongations is used, a curve may be obtained which shows the complete stress-strain graph, including rupture of the specimen.

The Southwark-Emery Stress-Strain Recorder is suitable for research work because of the high degree of precision of the diagrams obtained from it. It is suitable for routine testing because it is virtually fool-proof and is automatic in operation. It is a definite departure from the better known forms of "autographics." In most recorders, the force necessary to operate the apparatus is obtained from the deformation of the specimen. In this recorder the forces necessary to the motions of the recording elements are derived from a small electric motor. The extensometer and the loading element control the pencil and drum motions, just as the grid potential of a vacuum triode controls the current passing between anode and cathode. The sensitivity of the Southwark-Emery recorder is such that 0.00001 inch strain in the specimen produces a readable motion of the recording pencil. Strain magnification up to 1500 times may be obtained and this ratio is exact throughout the entire motion of the extensometer. The two ranges usually supplied with stock recorders are 250 and 500, but other ranges are available.



Speeds of testing up to the maxima specified by the A.S.T.M. may be employed while using the standard recorder, and the pencil will follow the test without lag. For speeds of testing higher than those above, it is necessary to make special provision in the recorder-drive mechanism.

Several curves may be drawn on the same chart by shifting the starting point of the pencil for each test. Stress-and-strain values may be accurately scaled from the chart from lines drawn through the origin of co-ordinates.

The principle of operation is based upon that found in the most accurate of recording instruments; namely, the use of an outside source of power (a small motor in this case) to operate the moving parts, the motion being controlled by the values to be measured.

The extensometer is built under exclusive license from the Goodyear-Zeppelin Corporation, of Akron. It was developed by them for testing duralumin sheet specimens and has been adapted for a wide variety of specimens by the Baldwin-Southwark Corporation. The extensometer is electrically connected to the recorder. As the specimen elongates, the electric contact is broken. The relays and solenoid system in the recorder, operating upon a sensitive toothed clutch, mechanically urge the spindle to follow up the retreating contact. The follow-up force is applied at the sheave, which may vary in diameter in accordance with the multiplication range desired. A micrometer head is fitted to the spindle to permit determination of the constants of the instrument. The mounting of the extensometer can be made quickly and simply. No gage marks are required.

The load element, by the same token, serves as a control. An Emery pressure element, one of those used in the Emery indicating instrument, by its elastic deformation under changing loads, operates a contact disk, which in turn acts upon a relay and solenoid system, a duplicate of the extensometer system, which in turn acts upon the sensitive clutch.

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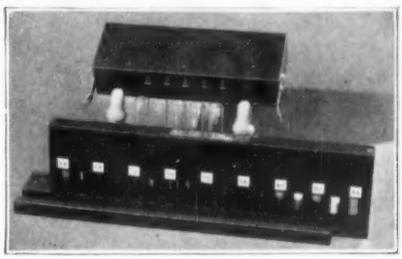
New Boiler Water Testing Equipment

W. A. Taylor and Company, Inc.

TWO new outfits for controlling the pH and phosphate content of boiler water, both similar in design and operation to the Slide Comparator shown in the illustration, can be secured as separate units or in combination as desired. All color standards used in these sets, as well as those employed in all other Taylor equipment, are guaranteed to retain their accuracy for a period of five years. This guarantee, it is asserted, is not carried by any other color standards on the market whether liquid or artificial.

The pH outfit contains a new indicator thymol red (yellow 8.0-11.2 red) developed by the manufacturers. The color standard slide contains standards from 8.0 to 11.2 in intervals of 0.4 pH, giving sufficient accuracy for boiler water control.

The phosphate slide comparator employs a method developed in the Taylor Laboratories with the purpose of eliminating errors due to constituents other than phosphate, such as silicate, iron, etc. Silicates as high as 1.0 percent as SiO_2 and ferric iron as high as 50 parts per million introduce no error. Ferrous iron does not interfere at all. The color standard slide contains standards for 5, 10, 20, 30, 40, 50, 60, 80 and 100 parts per million of phosphate as PO_4. Concentrations of phosphate up to 100 parts per million can be determined directly and higher concentrations can be taken care of by dilution. The reagents employed are very stable. The procedure is simple. Anyone can quickly learn to use the outfit. Only a few minutes are required to complete a test.



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Expansion-member Temperature or Humidity Regulators

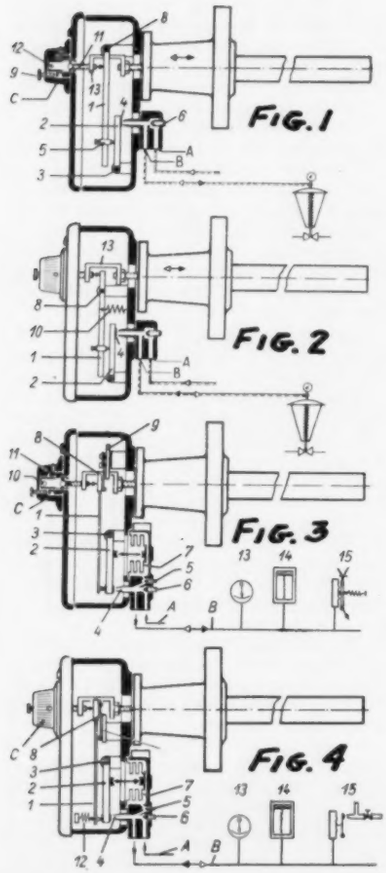
American Askania Corp.

FOR temperature control a rigid-stem expansion element is embodied in these four regulators; for humidity control a hygroscopic element. Temperature regulators are illustrated but the following description can be understood to apply also to humidity control. Compressed air at 8 lb./in.^{2} is the auxiliary power required.

Fig. 1 shows Regulator RTAO which, in the event of failure of compressed air supply, will fully *open* the diaphragm-motor valve on a *heating* medium line or fully *close* it on a cooling medium line.

Fig. 2 shows Regulator RTAU, which does the *opposite* in *either* case.

The motion of the thermo-sensitive element is transmitted over an adjusting screw 11 to levers 1 and 2; the latter opens more or less the air-leak, thus influencing the pressure in the chamber B, which in turn acts directly on the regulator. The more air is allowed to escape through the outlet 4 the lower the pressure in B. The ratio between the



movements of levers 1 and 2 can be adjusted by the movable piece 5, and the flow of air is adjusted by valve 6. The heat or humidity to be maintained is set by the button C.

The consumption of compressed air for a regulator depends on the velocity of regulation and amounts to about 7 cu. ft. per hour in average (referred to ordinary pressure).

Figs. 3 and 4 show Regulators WSPO and WSPU, which are a higher development of the above-described types. These two types, similarly, have "direct" or "reverse" action according to whether it is desired that an increase in elongation of the sensitive member will cause increasing or decreasing air pressure.

The more air is allowed to escape through outlet 4 the more the pressure in chamber B is decreased. The escape of air is regulated by the difference in elongation of a metal tube and a quartz rod; which acts on spring 1 and puts it more or less under tension and moves lever 2 toward the air outlet or away from it. The pressures in the chamber B can be pre-set by valve 6. The fact that the elongation acts against a spring (1) assures proportionality between temperature to be regulated and air pressure in chamber B.

The member for the heat regulation is a thin aluminum strip, while a very sensitive strip of hygroscopic wood about 20 in. long is employed for the regulation of humidity.

The operating heads of these regulators has its parts enclosed in a handsome rectangular case on the sides of which are two small pressure gages showing, respectively, the pressures in the air supply line and in the connection to the control devices.

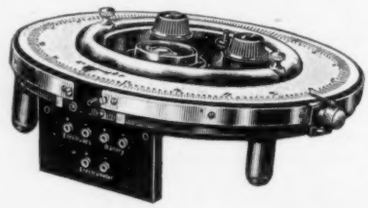
Discus Model Potentiometer

Hellige, Inc.

IN response to the demand for a direct reading potentiometer for technical pH measurements and other uses for which maximum accuracy can be sacrificed for the sake of simplicity, ease and speed of manipulation, this company has brought out the Discus potentiometer, in the form of a circular plate 12" in diameter. The pH graduation at the outer edge of the top is subdivided in 0.05 units from pH 0 to 14 in black for hydrogen and similar electrode systems, and from pH 0 to 8 in red for quinhydrone class electrodes.

In principle it is a true potentiometer and is somewhat similar to the standard model, with one important exception: it does not contain a standard cell, and none is required. The necessity for a standard cell is avoided by substitution of an indicator which shows at all times whether or not the potential applied to the potentiometric circuit by the battery is at the correct value for accurate measurements. This instrument is in plain sight at the top center of the disk, and at the slightest deviation from correct potential calls the attention of the operator to the necessity of readjustment of effective potential by means of coarse and fine resistances I and II. Precise adjustment is assured by two fine index lines, one etched on the glass cover, the other on the white surface below the indicating needle, avoiding parallax error. The possible error is well below 0.05 pH.

The principal potentiometric resistance is a wire stretched on the circumference of the disk, but well protected from accidental damage by a heavy metal rim machined to exact dimensions and serving as a track for the handle carriage bearing a rolling contactor on the resistance wire. The tapping key, at the



lower edge of the inner face of the instrument, is provided with means for automatically short circuiting the capillary electrometer when released, thus preserving the sensitivity of the latter. If desired, a galvanometer may be used as the null instrument.

The annular plate of non-corrosive white metal with satin finish on which are the graduations of the pH scale, may be revolved and clamped in the desired position. The indicating scale is made movable in this way to enable adjustment of its position relative to the main resistance wire, each part of which corresponds to a definite value for electrode potential; the potentiometer is thus made direct reading for any electrode system which may be employed in pH measurements.

Although any electrode system may be employed, the disk potentiometer is especially designed for use with a saturated potassium chloride-calomel half-cell and either the hydrogen or quinhydrone electrodes. To facilitate preliminary adjustment with these, there is provided a circular opening in the annulus bearing the pH scale. A white circle with black B, visible through this opening, indicates approximately correct adjustment for use with the hydrogen electrode, with correct readings of pH values from black graduations. When the plate is revolved sufficiently to expose a red C in a white circle, the adjustment is approximately that required for reading pH values from red graduations from the quinhydrone electrode system. When only an approximate indication is required, the proper marking may be brought to view and the scale clamped in position, omitting the preliminary test with standard buffer for precise adjustment.

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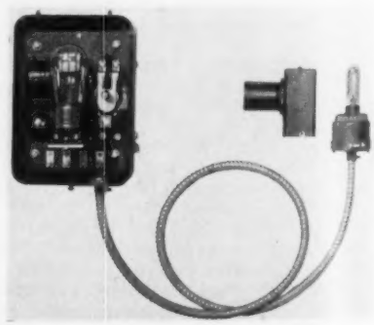
New General Purpose Photoelectric Relay

General Electric Company

A GENERAL purpose photoelectric relay with several new features, announced by this company, provides more sensitive control than the models which it supersedes and at the same time will permit operation at a minimum light intensity of three foot-candles. Ten foot-candles was the minimum light intensity prescribed for the old model. Other features of this new relay include improved dielectric strength through the use of a Bakelite panel, an improved phototube housing with a cast aluminum base and a drawn aluminum hood, reduced capacity leakage due to the use of flexible armored cable between the phototube and the relay proper, thus affording better operation in damp atmospheres. The relay uses a Pliotron tube specially designed for industrial purposes. Because of its improvements and refinements, the relay affords an even wider range of industrial applications than its predecessors. Characteristic applications include:

1. Operation of magnetic counters.
   a. Counting such items as bags and boxes of material.
   b. Counting vehicles or persons.
2. Control of mechanisms.
   a. Sorting objects according to size, shape, or reflecting ability.
   b. Aligning paper on rolls.
   c. Stopping paper machines when paper breaks.
   d. Deflecting packages on conveyors.
   e. Control of bag piling machinery.
3. Starting and stopping machinery.
   a. Where limit switches are not practical.
   b. Where articles are too small and light to operate a mechanical switch.

The illustration shows the relay with covers off, tubes in place, cover off phototube receptacle. The relay is approximately 10 in. high, 7 in. wide and 9 in. deep.



Diaphragm Flow Meters

Builders Iron Foundry

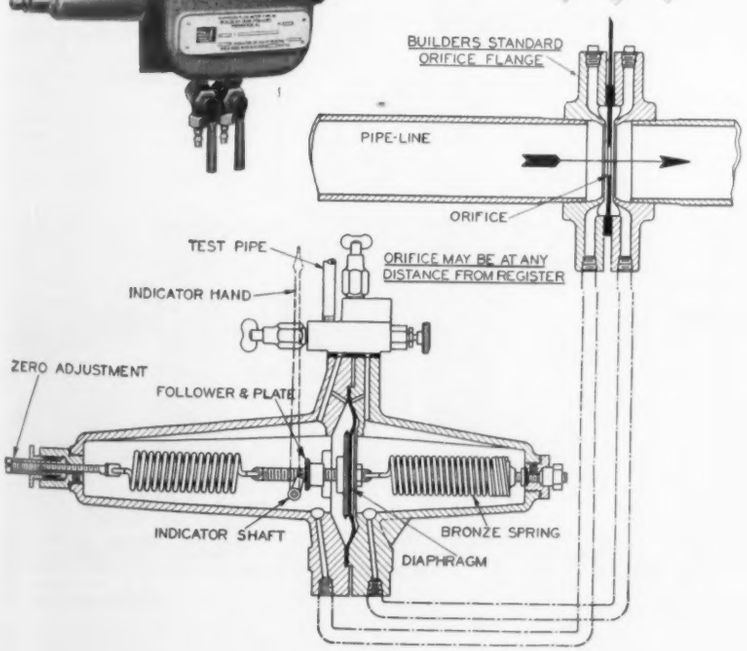
AN ORIFICE plate in the pipe line sets up a differential pressure proportional to the flow. This pressure moves a diaphragm in the meter, which operates the indicator hand by direct mechanical connection.

The diaphragm is restrained by two phosphor bronze springs and partly supported by a conical shield. Its movement is transmitted through a crank and shaft to the indicator hand which, due to the design of the diaphragm shield, moves nearly in proportion to the rate of flow over the range of the instrument. The shield also protects the diaphragm and prevents a change of area as it ages. The entire diaphragm case is of heavy bronze and is completely outside of and separate from the instrument case.

The indicator scale is decimally graduated, is 14 in. long, and has large white markings on a black background, making it readily legible at a distance.

A round chart, driven by a Telechron clock motor, makes the meter recording as well as indicating. Furthermore, total flow is also indicated by a counter. The counter is operated by a pawl and ratchet device, in which the pawl is driven by the chart clock motor, and moves the ratchet a varying amount depending on the position of the chart pen (i.e. rate of flow).

Height of the meter is 2 ft., maximum width 18 in., and its weight is 90 lbs. Zero setting can be checked without disturbing the flow or opening the instrument case.

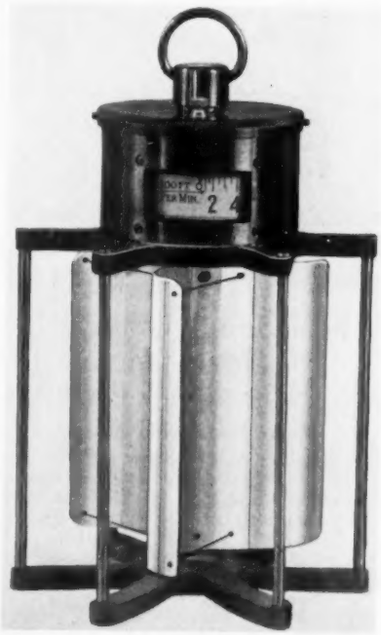


Direct Reading Anemometer

Mine Safety Appliances Co.

THE M-S-A Davis Direct Reading Anemometer is a new instrument for measuring air velocities like a speedometer indicates speed.

It introduces an entirely new idea for measuring the velocity of air currents by indicating, without the use of a watch, direct velocities from 100 to 3200 lineal feet per minute. Among the features are an automatic zero setting when inoperative; jewel mechanism, similar to that of



a high-grade watch; quick reading—velocity reading direct, thereby eliminating timing and correction chart. Change of air direction does not alter the efficiency for when the instrument is held in a vertical position, it indicates all the air currents with which it comes in contact, irrespective of the angle of direction.

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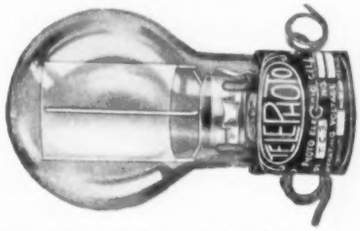
Caesium-Argon Photocells

Telephoto & Television Corp.

A COMPLETE line of photoelectric cells of the caesium-argon type is being developed by this company. Telephoto photoelectric cells are designed to operate at an anode voltage of 90 volts and at this voltage give an output suitable for use in the particular apparatus for which the cells were designed. Al-



though the cell is not injured by ionization or glow from short periods where a suitable series resistance is in the circuit, no higher anode potential should be used than 90 volts, as the positive ion bombardment of the sensitive surface by higher potentials will eventually impair the sensitivity of the cell and shorten its life.

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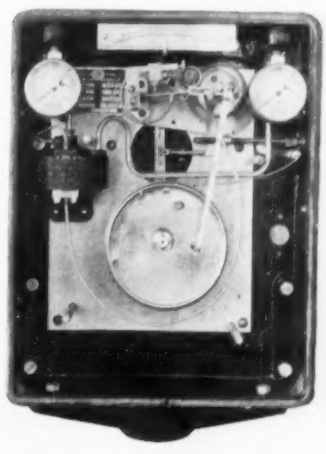
New Fully Compensated Flow Controller

The Neilan Co., Ltd.

AN improved line of flow control instruments is announced. These controllers are fully compensated by means of the advanced Neilan Volu-Pressure Compensator which irons out pulsations without any loss in sensitivity. Due to this simplified compensator, it is an easy matter for the average plant operator to obtain any degree of compensation that is required.

Another distinct feature is the ease with which the controllers may be changed from one differential range to another. The high and low pressure mercury pots have been replaced by two concentric stainless steel tubes. New differential ranges can be readily obtained by inserting new cylindrical tubes of the proper diameter. This provides conversion at a minimum expense while the stainless steel eliminates the possibility of inaccuracy due to corrosion. A number of other advancements are embodied in these new flow controllers.



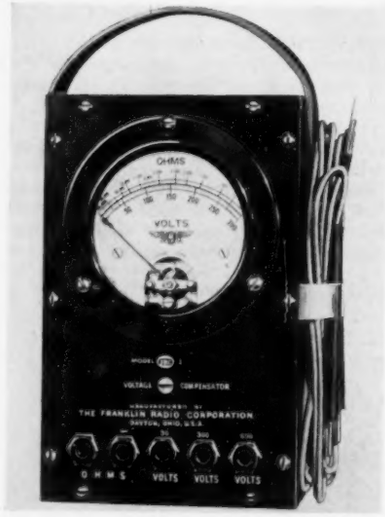
New Volt-Ohmmeter

The Franklin Radio Corporation

THE FRC Model 1 Voltmeter-Ohmmeter is a single, moderately priced instrument combining various ranges and testing facilities required for radio service work. It consists of a Bakelite case Jewell meter, with flush mounting on a laminated Bakelite panel, and housed in a hardwood case finished in oak. The pin jacks and push buttons are all mounted on the Bakelite front panel. A 4½ volt battery is enclosed in the case.

The battery is required for measuring resistance values and testing circuits. An outside voltage supply is unnecessary, and provision is made for battery voltage compensation.

The upper scale reads 0-100,000 ohms; the lower scale 0-300 volts. The resistance range can be reduced to one-tenth its value and the voltage range can be reduced to 3 or 30 volts and increased to 600 volts. When used as a voltmeter, the Model 1 has a resistance of 1,000 ohms per volt in each of its ranges, thereby measuring plate voltage without distortion.



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Novel Dead-weight Tester For Very Low Gage Pressures

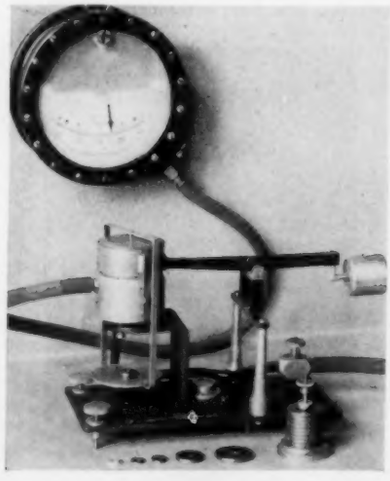
American Askania Corp.

SIMILAR in principle to other dead-weight testers but permitting the calibration of sensitive gages for gage pressures up to 4¼ in. water head in steps of 0.01 in., this new instrument should find uses wherever the customary method of using an inclined tube manometer or micromanometer proves too slow or otherwise objectionable.

It comprises two cups positioned mouth to mouth, the upper cup carrying a stirrup and pan. Not only can various weights be placed on the pan—each requiring a given pressure to lift the upper cup—but the weight on the threaded end of the balance beam can also be located to give a definite basic gage pressure.

A source of compressed air is required but no special regulator is needed, for the tester itself regulates the pressure acting on the gage being calibrated.

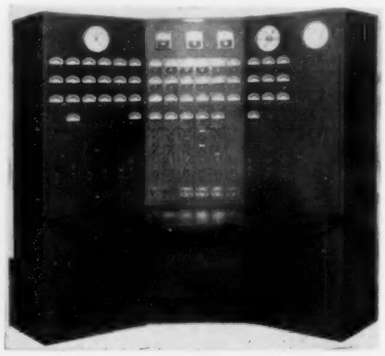
The tester weighs approx. 14 lbs. and measures 14x8x8 inches.



Miniature Switchboard Equipment for New Hydroelectric Plant

General Electric Company

THE hydroelectric station of the Appalachian Electric Power Company, near Lynchburg, Va., has recently been completely modernized and its apparatus is controlled by the miniature switchboard illustrated. The control board is constructed of sheet steel, with an ebony asbestos section for mounting the control switches and lamps. Space is available for a possible 18 control positions. The control switch and lamp sections are placed directly below the respective instruments for the circuits to be controlled. The operator controls all generators, transformers, and circuit switches without leaving his seat at the board. A complete set of miniature instruments is also provided to indicate power output and other necessary information. When a remote control unit is opened by a protective device, or from any source other than the operator's signal, a lamp lights and an alarm bell rings. The action of the remote control system is instantaneous as each device is controlled over its own individual wires. Anticipating a steady industrial growth at Lynchburg, the step up transformers in the outdoor substation have been provided with an extra winding, so as to permit the use of 33,000 volts for loop transmission at a later date. Ample space is allowed on the miniature switchboard for this future development.



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New Impact Tester

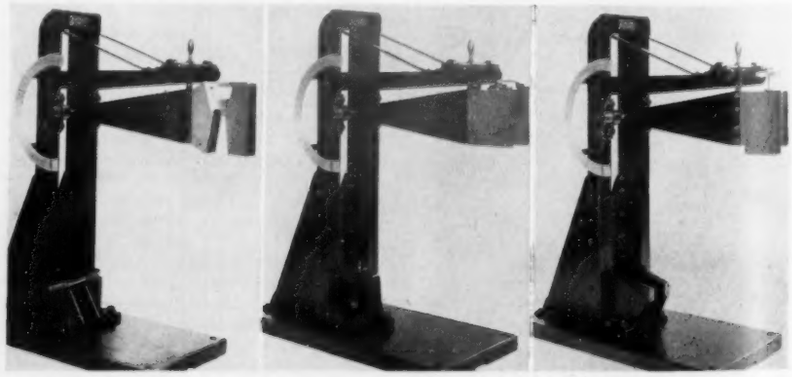
Testing Machines, Inc.

THE SCHOPPER Impact Testing Machine, as the photographs indicate, may be used for Charpy, Izod or Impact tension testing. It is available in capacities not exceeding 120 ft.-lbs. and, if desired, may be equipped for more than one testing range.

The scale readings are directly in foot-pounds of energy absorbed by the test specimen. In a combination machine there is a separate scale for each type of hammer.

It is claimed this machine approaches, as closely as is possible in this type of tester, the ideal impact tester. The ideal impact tester is one in which the center of gravity of the oscillating mass coincides exactly with the center of percussion. This would require that the striking hammer be suspended from a string so that all the weight would be at the point of percussion.

The impact tension testing device merits particular attention. The test specimen is inserted in the hammer and together with the check plate, all three acting together develop a kinetic energy of exactly 120 ft.-lbs. at the striking point. The check plate then drops off in consequence of the specimen having been broken. The scale is specially calibrated for the swing of the hammer after the specimen is broken and the check plate has been dropped. In this way an accurate measure is obtained of the resistance of the specimen to an impact tension force.



Charpy | Izod | Impact Tension

INSTRUMENTS ABSTRACTS

Abstracts on instruments and devices for measurement, inspection and control.

INSTRUMENTS ABSTRACTS, incorporated in INSTRUMENTS, is the most complete review on the subjects of measurement and control.

Abstractors cover over 700 domestic and foreign publications.

Upon receipt of the abstracts they are checked against permanent files to avoid duplication and after being rewritten to conform to our style they are classified.

Oftentimes an abstract can fit under two or even more sections. In that case we decide who will be most interested in the article, and include it under that field of reader interest. It is our aim to so arrange the abstracts that a person interested, for example, in viscosity, will keep in touch with all the important articles in his field if he reads only section 2.10. For instance, an article on "Vacuum Tube Means of Measuring Viscosity" appears under 2.10—under "Measurement and Control of Physical Properties—viscosity," although it would also fit under section (5.4)—"Electronic Devices and their Applications."

An improvement we hope to make in the Abstracts Section in the near future is the cross-indexing of articles which fit under several sections. We suggest glancing through the whole Abstract Section. This takes but a short time, and the time so taken will be found very profitably spent.

The classification number at the end of each abstract will be of assistance in mounting them on file cards.

Negative print photostats of the original articles abstracted can be obtained at 35 cents per page plus 10 cents for mailing. The remittance should accompany the order.

CLASSIFICATIONS

(By Fields of Reader Interest)

MEASUREMENT TECHNOLOGY (1)
This section includes all matters concerning the art and science of measurement as follows:
Measurement Theory (1.1)
Under this heading will be included: definitions, precision of measurements, systems of units, and dimensional analysis.
Measurement Practice (1.2)
Covers Calibration and Standardization.
Calculation (1.3)
This does not include computation for instrument design, but covers calculations as a mode of measurement.
MEASUREMENT and CONTROL (2)
This section is devoted to those general measurement practices and control applications that are not confined to any one industry or branch of engineering. Thus temperature measurement and control, being of as much importance in chemical as in metallurgical processes, is a general field of interest to all industries and all branches of engineering.
Length, Angle, and Area, Including Surveying (2.01)
Time, Speed, and Acceleration (2.02)
Weight, Density, and Specific Gravity (2.03)
Pressure and Vacuum (2.04)
Flow and Volume (2.05)
Temperature (2.06)
Heat and Combustion (2.07)
Humidity and Moisture (2.08)
Power, Work, and Output (2.09)
Physical Properties, (Viscosity, hardness, elasticity, plasticity, surface tension, etc.) **(2.10)**
Liquid Level (2.11)
TESTING and INSPECTION (3)
Physical Testing and Inspection (including strength tests, bending, magnetic analysis, X-ray inspection, and other engineering test or inspection methods.) **(3.1)**
Production Testing and Inspection (This includes methods of testing and inspection for setting up production standards, grading, gaging, maintaining quality, etc.) **(3.2)**
Maintenance Testing and Inspection (Included here will be matters concerning standards and methods for controlling performance or service of equipment. Example—The problem of controlling long phone lines to give quality sound transmission would be included here.) **(3.3)**
ELECTRICITY and MAGNETISM (4)
Electrical Properties, Tests, Measurements, and Measuring Instruments (4.1)
Electrical Measuring Devices and Applications (4.2)
Magnetic Measurements (4.3)
Magnetic Properties, Materials, and their Applications (4.4)
ELECTRONICS and RADIO (5)
Radio Measurements (5.1)
Applications of Radio to Measurement and Control (5.2)
Photo-electric Measurements, Devices and Applications (including television) **(5.3)**
Electronic Measurements, Tubes, Devices, and their Applications (Under this heading would be included thermionic tubes, grid-glow tubes, thyratrons, neon discharge tubes, cathode-ray tubes, etc.) **(5.4)**
ACOUSTICS and VIBRATIONS (6)
Sound, Vibration, Phenomena and Measurements (6.1)
Sound and Vibration Devices or Applications (6.2)
LIGHT, OPTICS, and RAYS (7)
Light—General Measurements and Optical Applications (7.1)
Color Analysis, Color Matching (7.2)
Photometry (7.3)
Polarimetry (7.4)

(Continued on page A23)

A PRACTICAL CATHODE-RAY OSCILLOGRAPH

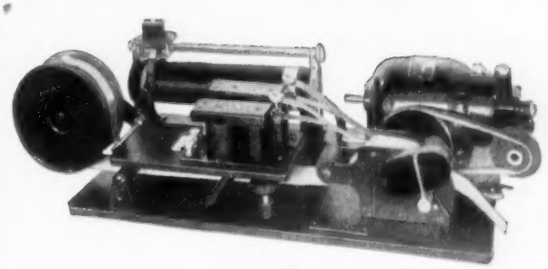
The inertialess moving element in the cathode-ray oscillograph insures uniform response over a wide frequency range. It is now made available for the viewing of recurring phenomena by means of the recently developed sweep circuit (licensed under Bedell patents).

The price of the complete cathode-ray oscillograph ready for operation from the a-c line is $280.00; that of the sweep circuit is $170.00.

Write for a copy of the General Radio Experimenter describing this equipment. Address the General Radio Company, Cambridge, Massachusetts.

GENERAL RADIO CO.
INSTRUMENTS OF PRECISION AND DEPENDABILITY

CHRONOGRAPHS



A-377

WE manufacture an extensive line of Chronographs suitable for recording time intervals from many hours duration down to hundredths of a second and less. These Chronographs find numerous applications in Laboratories, Time Study Operations, Sporting Events, Astronomical Observatories, etc., where accuracy is an important feature.

Detailed Information will be send on application.

The GAERTNER SCIENTIFIC CORP.
1201 Wrightwood Ave. Chicago, U. S. A.

MEASUREMENT TECHNOLOGY (1)

New Set of Standard Engineering Symbols. *Engineering News-Record*, Vol. 108, April 14, 1932, page 545.

Set devised by joint committee of leading societies through the American Standards Association. The list is complete in the article. CBJ (1)

Dimensional Formulae of Electric and Magnetic Units. (Sur les formules de dimensions des grandeurs électriques et magnétiques.) E. Brylinski. *Revue Générale de l'Electricité*, Nov. 14, 1931, pages 779-781.

Simplifies usual formulae by substituting for mass as the fundamental unit, either force or density. In interpreting these formulae, author refrains from assuming that specific inductive capacity or magnetic permeability is a pure number, and shows that electric and magnetic units are not convertible to common mechanical units. MS (1.1)

Measurement Practice (1.2)

Practical Rules for the Determination of the Constants of a Magnetometer. (Règles Pratiques pour Déterminer les constantes d'un Magnétomètre.) C. L. Alexanian. *Annales Combustibles Liquides*, Vol. 6, March & April, 1931, pages 261-267.

Simple method is described for the determination of the constants of the meters of Lloyd-Schmidt and of Haalck. (1.2)

Capacitance and Power Factor of a Mica Capacitor as Measured at the Bureau of Standards and the National Physical Laboratory. Harvey L. Curtis, C. Matilda Sparks, L. Hartshorn & N. F. Astbury. *Bureau of Standards Journal of Research*, Vol. 8, Apr. 1932, pages 507-523.

A mica capacitor has been transported on 4 occasions between the Bureau of Standards and the National Physical Laboratory, England. 7 sets of measurements of capacitance and power factor were made on the instrument, 5 here and 2 in England. During the first transportation changes occurred in the capacitance, which made the results of little value. No certain changes, however, occurred during subsequent transportations. The principles underlying the methods of the 2 laboratories are quite different. At the Bureau of Standards the mica capacitor was compared by alternating current with an air capacitor, the capacitance of which can be determined in terms of resistance and time. At the National Physical Laboratory the mica capacitor was compared by alternating current with a mutual inductance, the value of which can be computed from its dimensions. Results show that the 2 methods give values in good agreement. The measured capacitances agree to 1 or 2 parts in 10,000, which is about the accuracy of the measurements. WAT (1.2)

Calculation (1.3)

Calculator for Wiring and Motor Data. Square D Co. *Instruments*, Vol. 5, May 1932, page 131.

Brief illustrated description of new duplex rotary device. MFB (1.3)

Strength of Corrugated Steel and Iron Sheets Reviewed. Robins Fleming. *Engineering News-Record*. Vol. 108, March 17, 1932, pages 399-400.

Present safe-load tables are based on formula published by Rankine in 1862. Rankine's formula was that $W = 32/15\ f_s\ h\ b\ t/l$. W is load in pounds, f_s the modulus of rupture by crippling at the compressed part, h the depth from ridge to furrow, t the thickness of the sheet, b the breadth of the corrugated iron, and l the length of the span in inches. Different values have been assigned to f and different ratios of safe to breaking loads have been assumed. CBJ (1.3)

Calculation of Intersections by Simultaneous use of two Calculating Machines. (Schnittberechnung durch Gleichzeitige Verwendung zweier Rechenmaschinen.) R. Gutmann. *Zeitschrift für Vermessungswesen*, Vol. 51, Feb. 15, 1932, pages 118-120.

Demonstrates a method which simplifies the calculation of intersecting points in surveying. Ha (1.3)

Approximate Calculation of the Losses in the Cast Steel Ring of Soederberg-Electrodes. (Angenäherte Berechung der Verluste im Stahlgussring bei Soederberg-Elektroden.) W. R. Blumer. *Elektrotechnische Zeitschrift*, Vol. 52, Dec. 24, 1931, page 1580.

The author tried to calculate the eddy current losses in a water-cooled steel ring electrode of an electric furnace for 70,000 amp.; he arrives at a figure of 55 KW. To reduce this value it is proposed to put a protective copper layer on the ring. Ha (1.3)

MEASUREMENT & CONTROL (2)

Length, Angle, and Area, Including Surveying (2.01)

Photocell Integrator for Irregular Areas. T. S. Gray. *Electronics*, March 1932, page 98.

The photoelectric cell has been applied as an integrator or computer of irregular areas by Dr. T. S. Gray of the Massachusetts Institute of Technology, utilizing the method of first cutting out the space below the graph or curve to be measured. Light is then allowed to shine through this opening, and the ratio of this light to that passing through a unit area, at once gives the area of the irregular graph in terms of the measurable area. HO (2.01)

A New Tape-Rule. The Lufkin Rule Co. *Instruments*, Vol. 5, April 1932, page 108.

Describes new pocket tape also usable as rule: can be projected unsupported to walls or into openings. 1 fig. MFB (2.01)

An Old Die Sinker Chats. A. G. Trams. *Heat Treating and Forging*, Vol. 18, Jan. 1932, page 38.

Includes description of a device for determining the taper of bores. MS (2.01)

A Micrometer That Reads to Tenths. George J. Murdock. *American Machinist*, Vol. 76, Jan. 28, 1932, page 143.

Describes and illustrates a micrometer designed for rapid accurate work. No vernier is used. It is possible to estimate to hundred thousandths of an inch. RHP (2.01)

Contact Errors of the Measuring Pieces of Thread Gages. (Beruehrungsfehler der Messstuecke-von Gewindernehmlehren). Hanns Schmidt. *Messtechnik*, Vol. 7, July 1931, pages 175-179.

The theoretical basis of various shapes of thread gages is derived and investigated. It is shown that comb-like gages can have considerable errors; a formula is developed for the calculation of the error. It is pointed out that not the contact error, but rather other practically important qualities, bear on the merit of the gage. Ha (2.01)

Time, Speed, and Acceleration (2.02)

A New Electric Tachometer for Testing Purposes. L. F. Holder. *General Electric Review*, Vol. 35, Feb. 1932, page 131.

The new apparatus consists of a small tachometer generator, a saturating-core transformer, and a sensitive multiscale portable voltmeter calibrated to read directly in r.p.m. Advantages: no gear box, hence range changed without shut-down or disconnecting tachometer; and independence of direction of rotation. The a.c. generator consists essentially of a small rotating toothed steel core and stationary permanent magnet around which the armature coils are placed. WHB (2.02)

New Hand Tachometer. Amthor Testing Instrument Co. *Instruments*, Vol. 5, July 1932, page 179.

Brief illustrated description of new portable speed indicator with 4 ranges on 1 dial, available in ranges up to 12,000 r.p.m. MFB (2.02)

Novel Method of Production Timing. O. J. Poupitch. *Instruments*, Vol. 5, July 1932, pages 165, 168.

Apparatus devised by T. N. Whitehead at Hawthorne Works, Western Electric Co., records on one wax-impregnated paper tape the production of 5 operators. Tape travels at approx. ¼-in. per min. through punching mechanism actuated remotely upon completion of each finished unit, and is subsequently interpreted by means of a standard Gaertner Scientific Instrument Co.'s comparator modified to suit particular requirements. Results invariably satisfactory to employers and workers. MFB (2.02)

Governor for Turbine-Driven Feed Pumps. *Power*, Vol. 73, Apr. 21, 1931, page 643; Vol. 75, Feb. 23, 1932, pages 309-310.

Descriptive. AHE (2.02)

Pneumatic Cycle Controllers. *Power*, Vol. 74, Aug. 4, 1931, page 178; Vol. 75, Feb. 23, 1932, page 310.

An instrument is described lending itself to control where a certain degree of interlocking is required. AHE (2.02)

Time-Cycle Regulator. *Power*, Vol. 73, March 24, 1931, page 493; Vol. 75, Feb. 23, 1932, page 310.

An electrically driven cam as it revolves progressively opens or closes small pilot valves which supply compressed air to diaphragm valves, electro-pneumatic switches, etc. AHE (2.02)

Non-Recording Time Controller. *Power*, Vol. 74, Oct. 20, 1931, page 582; Vol. 75, Feb. 23, 1932, page 309.

A controller designed to maintain a predetermined cycle of operation in any process involving temperature or pressure is described. AHE (2.02)

Operation Recorder. *Power*, Vol. 74, Oct. 20, 1931, page 583; Vol. 75, Feb. 23, 1932, page 281.

The instrument records time of operation and shutdown of a machine or unit. AHE (2.02)

Vibroscope with Increased Illumination. *Power*, Vol. 73, Mar. 10, 1931, page 419; Vol. 75, Feb. 23, 1932, page 285.

Stroboscopic device, range 40 to 12,000 cycles per min. AHE (2.02)

Modern Developments in Precision Clocks. Alfred L. Loomis & W. A. Marrison. *Bell Telephone System Technical Publications*, Monograph B-656, 1932, 30 pages.

In 1911 astronomical clocks accurate to 1/30 second per day were considered the acme of mechanical science. A time keeper capable of an accuracy of 0.0001 second per lunar day is described. The constancy of rate of certain mechanical resonators, maintained in vibration by vacuum tubes, is now comparable with that of the best pendulum clocks. The most accurate oscillators of this type known to the authors are controlled by plates of quartz crystal vibrating at a high frequency, that is, high in comparison with the frequency of a pendulum. Probably the most accurate of these at the present time are a set of four 100,000-cycle oscillators built by the Bell Laboratories for use as a primary frequency standard. In order to operate clock mechanisms in the most direct way it is necessary to control from this high frequency another which is low enough to operate a synchronous motor. This is done by an electrical circuit known as a sub-multiple generator which controls one frequency at a definite fraction of another in absolute synchronism. While the crystal clock is more costly than a pendulum clock and requires more elaborate electrical equipment, it is decidedly superior because of its great versatility. Details of hookups and results of a number of test runs are described in detail. 24 references. WAT (2.02)

On Some New Forms of the Method of Recording and Observing the Angular Variations of Internal-Combustion Engines. (Sur quelques formes nouvelles de la méthode d'enregistrement et d'observation des écarts angulaires des machines a explosions.) André Blondel. *L'Industrie Électrique*, Jan. 25, 1932, pages 47-48.

Describes method for the stroboscopic study of the oscillations of the speed and vibrations of shafts. Uses a photoelectric tube in conjunction with a disc revolving on the shaft under observation. A neon lamp is used as the source of light, instead of an arc-lamp. MS (2.02)

The Measurement of Accelerations in the Operation of Automobiles. (Das Messen von Beschleunigungen im Kraftwagen betriebe.) Jos. Geiger. *Automobiltechnische Zeitschrift*, Vol. 35, Jan. 25, 1932, pages 31-37.

An analytical treatment of the conditions of acceleration and deceleration and the requirements which an instrument must possess to give a continuous record of operating conditions when changing gears. An instrument is briefly described and a few test curves with it reproduced. Ha (2.02)

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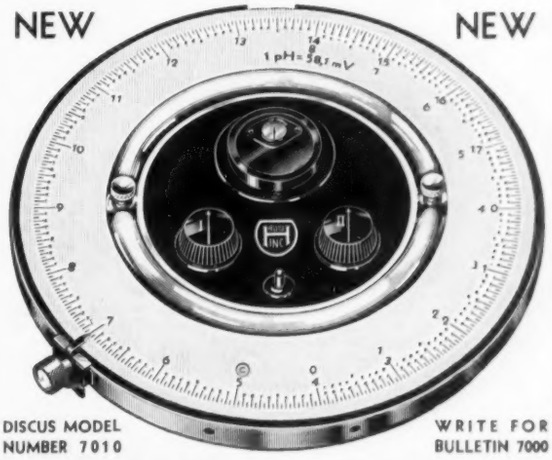

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Weight, Density, and Specific Gravity (2.03)

Automatic Material Batchers at Hoover Dam. *Engineering News-Record.* Vol. 108, April 14, 1932, pages 534-537.

Electrically controlled equipment installed to batch and mix 280 cu. yd./hr. to meet rigid specification requirements. The composition and consistency of each batch is recorded graphically. CBJ (2.03)

Photo-Electric Scale Control. General Electric Co. *Instruments,* Vol. 5, March 1932, page 81.

Describes new device for passing pre-determined weight through hopper. MFB (2.03)

Boiler Water Test-O-Meter. E. Edelman & Co. *Instruments,* Vol. 5, March 1932, page 81.

Illustrated description of new combined hydrometer and thermometer with special scale and conversion table. Concentration of mineral salts read directly in grains/gal. or parts per million. MFB (2.03)

Photo-Electric Weighing Control. General Electric Co. *Instruments,* Vol. 5, May 1932, page 131.

Illustrated description of new device for automatic proportioning of concrete aggregates. Comprises photoelectric tube, lamp and reflector, light "interceptor" with a paddle-like tip attached to the weight indicator, relay, etc. MFB (2.03)

Chain-Poise Variable-Weight Balance. The Heusser Instrument Mfg. Co. *Instruments,* Vol. 5, May 1932, page 130.

Illustrated description of new small-load dual-purpose balance utilizing variable-weight in the form of a chain weight suspended from an auxiliary arm attached to the balance beam. MFB (2.03)

Improved Printing Scale. Toledo Scale Co. *Instruments,* Vol. 5, June 1932, page 162.

Description, photo, of new scale featuring a selective numbering device, a delayed time switch and the application of the photoelectric tube. MFB (2.03)

Micro-Balance. Christian Becker, Inc. *Instruments,* Vol. 5, July 1932, page 182.

Brief illustrated description of "chainomatic column" balance newly brought out. MFB (2.03)

Specific Gravity Indicator and Recorder. *Power,* Vol. 74, Oct. 27, 1931, page 618; Vol. 75, Feb. 23, 1932, page 280.

General. AHE (2.03)

Measurement of Gas Density. (Gasdichte-Messung.) Josef Kroenert. *Archiv für Technisches Messen,* 1931, section V9131-1, page T55.

The methods of determining the density of a gas by weighing, by absorption, by buoyancy, by comparing a column of gas with a like column of air, by flow and escape are described. Ha (2.03)

Continuous Weighing with Light-Sensitive Cell. E. J. White. *Scale Journal,* Vol. 18, Jan. 1932, pages 10-11.

A device, called the "Telepoise," is described which records the weights of materials in transit on conveyor or feeder scales. It works on the idea of interrupting a light beam a varying number of times depending on the momentary weight passing over the scale section, and converting the light impulses into corresponding electrical impulses for the actuation of an electric counter. The construction of the device is described. Ha (2.03)

Photo-Electric Conveyor Scale. Burgess Battery Company. *Instruments,* Vol. 5, Feb. 1932, page 55.

This new photo-electric apparatus is for measuring and recording the weight of bulky material as it passes along on a conveyor. As load is placed on the belt the beam swings upward proportionately, bringing the focused point of light higher and higher on the chopper cylinder, so that more and more slots admit light and cause a corresponding number of impulses to actuate the electrical integrator. The integrator is simply an electro-magnetic counter with a number of units to represent the grand-total of integrated weights. Ho (2.03)

Pendulum Balance Scales. Hamelin Accurate Weigher Co. *Instruments,* Vol. 5, Feb. 1932, page 59.

This scale indicates weights by the amount they deflect a vertical pendulum. Only one moving element is used—the vertical pendulum, which is balanced on knife-edges. Ho (2.03)

Wire Cable Tension Indicator. *Power,* Vol. 74, Dec. 1, 1931, page 808; Vol. 75, Feb. 23, 1932, page 286.

An indicator for obtaining line loads on cranes, guys, transmission lines, etc. and for determining pull on hoists and elevators up to 26,000 lbs. has adjustable clamps between which the loaded line is offset by a projection carried by a pressure plate. This pressure plate bears against a diaphragm backed up by a body of fluid. The hydrostatic pressure deflects a gage calibrated for line load. AHE (2.03)

Device for Estimation of Density of Gems and Small Amounts of Solids. Eugene W. Blank. *Industrial Engineering Chemistry, Analytical Edition,* Vol. 3, Jan. 15, 1931, pages 9-11.

7 references. The device is made of glass. A narrow tube is filled with a suitable liquid to a mark on a side capillary tube. The sample is inserted in the liquid, and more liquid added from a weight buret to bring the liquid level to a second mark on the capillary. The weight of the liquid required to fill the instrument from the lower mark to the upper mark is previously determined. Knowing the density of the liquid used, a little calculation gives the density of the sample. MEH (2.03)

The Comparison of Gaseous Densities by the Method of Balancing Columns. Arthur H. Snell & A. Norman Shaw. *Canadian Journal of Research,* Vol. 6, Mar. 1932, pages 309-321.

Paper describes an application of the principle of balancing columns to the comparison of gaseous densities at any ordinary pressure, the precision of a given apparatus depending upon the heights of the columns, the sensitivity of the pressure gage, and the extent of uncontrolled fluctuations in temperature. Without thermostatic control, and employing a simple modified form of the Toepler micromanometer with columns 12 m. in height, a sensitivity of 10^{-7} g. per cc. is obtained. 4 diagrams and 1 table. OWE (2.03)

Pressure and Vacuum (2.04)

An Improved McLeod Gage. Samuel D. Bryden, Jr. *The Review of Scientific Instruments,* Sept. 1931, pages 514-518.

A "short form" of McLeod gage has improvements consisting of a simplified and compact construction of the compression chamber and mercury cistern, and of the entrance of the tubing connecting the gage with the vacuum system directly through the top of the compression chamber. The theory of the McLeod gage is briefly considered and the possible advantages of combining a controlled compression or expansion chamber with several existing gages are indicated. Drawing and photograph. (2.04)

Electrically Operated Recording Manometers. J. H. Pound. *Refiner and Natural Gasoline Manufacturer,* Vol. 10, Sept. 1931, pages 88-92.

Recorders and indicators can be located at a considerable distance from the manometers. (2.04)

Mechanical Recording Manometers. J. H. Pound. *Refiner and Natural Gasoline Manufacturer,* Vol. 10, Aug. 1931, pages 91-96.

This second article by Prof. Pound discusses only the general principles of mechanically operated recording instruments. (2.04)

A New High Vacuum System. J. A. Becker & E. K. Jaycox. *Bell Telephone System Technical Publications,* Monograph B-636, 1932, 12 pages.

A new high vacuum pumping system is described in which "oil" (an organic liquid having physical properties commonly associated with oil) is used in a diffusion type pump, and a trap containing activated cocoanut charcoal replaces the usual liquid air trap. The system is capable of attaining a vacuum of 2 x 10^{-8} mm. of Hg. A high degree of vacuum can be attained as quickly as with a Hg diffusion pump and liquid air trap. The system is especially adapted to maintaining a low pressure for several days in apparatus which cannot conveniently be sealed off from the pumps. WAT (2.04)

Recording Absolute Pressure Gage. *Power,* Vol. 75, Jan. 12, 1932, page 75.

A direct-reading absolute pressure gage designed to obviate the necessity of applying barometric corrections to vacuum reading in connection with operation of turbine condensers, vacuum pans in sugar drying, vacuum oil stills, etc., has been developed by the Bristol Co. AHE (2.04)

The Hydraulic Gage, Its Application, Construction, Filling and Calibration, Demonstrated by an Example of a Device for Measuring the Pressure of Rolls. (Die hydraulische Messdose, ihre Anwendung, Konstruktion, Füllung und Eichung, gezeigt an einem Beispiel einer Walzdruck messvorrichtung.) W. Reichel. *Die Messtechnik,* Vol. 7, Sept. 1931, pages 231-239.

The hydraulic gage is much simpler and more rugged for use in the shop than measuring pressures by piezo-electricity or condenser changes. An example is described in detail where the tangential pressures and radial pressures are recorded which occur in cold-rolling of threads, and it is shown how one has to proceed in the design, testing, filling and calibration of recording instruments. It is recommended in order to eliminate dead play in the recorder as also for sudden loads, to arrange for a pre-tension in the gages of about 5%; the hereby existing inaccuracy of about 1.7% can be neglected. Eight references. Ha (2.04)

Mechanical Indicators. (Mechanische Indikatoren.) H. D. Brasch. *Archiv für Technisches Messen,* 1931, Section J137-1, pages 759-60.

The different types of pressure indicators for gases, vapors or liquids are explained and their behavior and characteristics discussed. Thirteen references. Ha (2.04)

Measurement of Oscillating Pressures; Indicators for High-Speed Motors Using the Condenser Method. (Messung oszillierender Drucke; Indizieren raschlaufender Motoren nach der Kondensatormethode.) Kurt Schnauffer. *Archiv für Technisches Messen,* 1931, section V1344-2, page T83.

The method consists of an oscillating circuit with very high natural frequency which is fed by a sending tube and coupled with a second oscillating circuit which is connected to the grid of a rectifier tube; a measuring condenser of variable capacity is inserted in the second circuit. The capacity of the condenser is changed by the oscillating pressure and influences thereby the frequency of the second circuit and the voltage on the grid, the corresponding change of anode current is recorded by an oscillograph. The construction of the condenser is described and oscillograms reproduced. Ha (2.04)

Measurement of Oscillating Pressures with Mechanical Indicators. (Messung oszillierender Drucke mit mechanischen Indikatoren.) A. V. Gehlen. *Archiv für Technisches Messen,* 1931, section V 1344-1, pages T81-82.

The taking of indicator diagrams over time or length is explained and the method of recording time intervals described. Calibration of indicators, sources of error, influence of natural frequency and damping and obtainable accuracy are discussed. Ha (2.04)

New Recording Absolute Pressure Gage. Bristol Company. *Instruments,* Vol. 5, Jan. 1932, page 26.

When a high reading vacuum gage is compensated for barometric pressure changes, it becomes in actual use a low range absolute pressure gage. This new instrument is a direct reading, absolute pressure gage of the recording type. Ho (2.04)

High Range Manometer. The Meriam Company. *Instruments,* Vol. 5, Feb. 1932, page 59.

The purpose of this instrument is to supply a light, portable instrument for checking the accuracy of recording flow meters. Ho (2.04)

Instruments in the Refinery and Natural Gasoline Plant. W. C. Begeebing. *Petroleum Engineering,* Vol. 2, Sept. 1931, pages 71-72, 75. Article 2, continued from July issue.

Automatic control instruments; pressure spring, expansion stem, and electrical, are discussed. (2.04)

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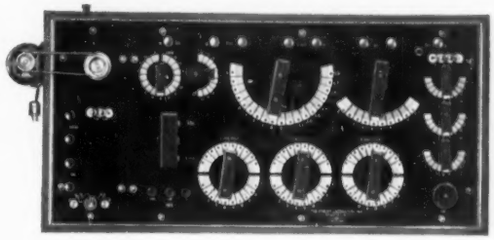

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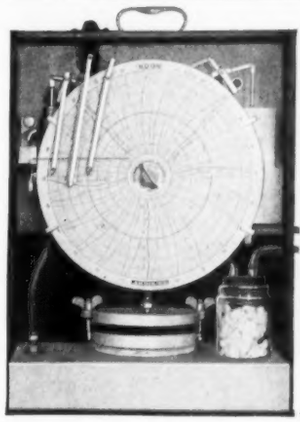

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Flow and Volume (2.05)

Piezometer Investigation. CHARLES M. ALLEN AND LESLIE J. HOOPER. *Hydraulic Division paper, 1931 Annual Meeting, American Society Mechanical Engineers.* 11 pages.

The manufacturers of head meters do not fail to recommend that holes for pipe connections be drilled perpendicularly, that burrs be removed from the edges, that these edges and the inside of the pipe be inspected if possible, that the surrounding area of the inside of the pipe be smoothed if possible, and that nipples should not protrude inside the pipe. Experience has shown that even strict observance of these precautions—of these precautions *only*—is not sufficient for the best results. This report covers an investigation at the Worcester Polytechnic Institute "to determine a stable type of 'piezometer' suitable for use as a standard in commercial work, and to determine those factors which have the greatest bearing in obtaining correct results." 30 "piezometers" were tested, fourteen of them "flush" (that is to say "pressure holes") the others "recessed" or with parts protruding variously inside the test section of the 12-in. pipe in the Hydraulic Laboratory set-up. Of the 14 flush pressure holes, some were square-edged but varying from 1/16-in. to ½-in., and others—also of various sizes—had edges with various radii of rounding. The conclusions (in which "piezometer" means the pressure hole itself or the plug or other device for taking off line pressure and "orifice" means the hole in the plug when a plug was used or at the end of the nipple or tube when nipples or tubes were flush or protruded inside the pipe) are as follows: (1) The error of a piezometer is a constant percentage of the local velocity head existing at the orifice. (2) The size of the opening has no effect within the limits tested, which were from 1/16-in. to 27/32-in. opening and mean velocities up to 7.3 ft. per sec. in a 12-in. pipe. (3) A true square-edged orifice is accurate, but very sensitive to slight changes in construction and position. (4) A standard piezometer plug or plate must be absolutely flush with the conduit wall. (5) A piezometer that projects beyond the pipe-wall surface has a large negative error. (6) The burr must be carefully removed from a square-edged orifice. (7) A piezometer plate or plug is not sensitive to minute abrasions on its surface. (8) A piezometer orifice must continue with parallel sides for over two diameters into the plug before its shape is changed. (9) The inside penstock wall should be scraped clean for at least 1 ft. upstream from a piezometer. (10) the piezometers to determine true pressure head should not be installed where there is any chance of the water whirling in the pipe or immediately downstream from an obstruction, such as a butterfly valve, a rivet head, or a plate joint. (11) An inserted tube pointed on the upstream end and with piezometers on the side gives a correct pressure-head reading, but it is very sensitive to angularity. (12) A tea-ball piezometer has a large negative error, but it is not sensitive to the direction of the flow of the water. (13) A conical piezometer has a very large negative effect, but must be used with extreme care and calibrated. (14) An orifice with a large radius of rounding has a small positive error. (15) An orifice with ¼-in. hole and 1/16-in. radius of rounding is recommended for standard practice. MFB (2.05)

Investigations of Gas Flow Through Thin-plate Orifices (Recherches expérimentales sur l'écoulement des gaz à travers les orifices en mince paroi). M. BARBIER. *Chaleur et Industrie,* January 1932, pages 25-28.

Apparatus described. Effects of heating gas at various points discussed. Results tabulated and numerous formulae given. Practical uses of local heating of pipe suggested for regulating gas-fired furnaces. FR + MFB (2.05)

The Dam-Grate, a New Measuring Instrument with Low Pressure Gradient for Flow Measurements. (Der Stanrost, ein neues Messgerät mit geringen Druckabfall für Durchflussmessungen.) ERNEST SCHMIDT. *Zeitschrift Verein deutscher Ingenieure,* Vol. 75, Dec. 19, 1931, pages 1535-1538.

A new instrument for the measurement of the flow of gases or liquids in pipe lines is described which is particularly remarkable for its very small loss of pressure and compact construction, and can also be used for rectangular sections. It consists of parallel rods or bars having a section formed according to stream lines and held together in a frame. The stream-line bars are arranged transversely to the flow and form openings with sections similar to those in a Venturi-tube. Test results show that the pressure loss of the new instrument is still less than that of the Venturi tube although its length is shorter than the Venturi tube, occupying only about a half pipe diameter which mean 1/10 to 1/20 of the length of the Venturi tube. Test results are given and the formulas for the evaluation are developed. Ha (2.05)

Flow Measurement with Float Meters. (Durchfluss-Messung mit Schwimmer-Messern.) G. RUPPEL. *Archiv für Technisches Messen,* 1931, section V1247-1, page T65.

This type of instrument is used to measure the quantity of a liquid, gas or vapor flowing in the unit of time through a closed pipe line under pressure. The position of the float changes with the resistance it finds with the changing flow. The mathematical expressions are developed and the influence of the compressibility of the medium, its specific gravity, and the accuracy are discussed. Ha (2.05)

The New Siemens Ring-Plunger Water Meter and Its Application. (Der neue Siemens-Ringkolben-Wassermesser und seine Verwendung.) G. EGGERS. *Siemens-Zeitschrift,* Vol. 11, Aug./Sept. 1931, pages 406-412.

A small water meter for house installations with an excentrically rotating plunger; the latter and also the measuring chamber are made of high-grade hard-rubber while the housing is made of bronze in order to prevent corrosion by water. Ha (2.05)

Weir Meters. VULCAN COPPER & SUPPLY CO. *Instruments,* Vol. 5, May 1932, page 133.

Brief illustrated descriptions of new V-notch meters with sight gages. Small size takes plates having capacities of 200 to 2000 gals./hr.; large size from 2000 to 5000. Each weir is individually graduated. MFB (2.05)

Rudiments of Orifice Metering. L. K. SPINK. *Gas Age-Record,* Vol. 69, Mar. 5, 1932, pages 270-272, 290-291.

Historical review, discussion of requirements for obtaining accurate measurements. Installation governed by manufacturer through design of equipment and through installing instructions. Care of installation is principally a matter of maintaining the flange, plate, line, piping and instrument clean and free from leaks. Accurate computation of results may be assured by following handbook of any recognized meter manufacturer. VVK (2.05)

Methods of Computing Orifice Sizes. L. K. SPINK. *Oil and Gas Journal,* Vol. 29, May 7, 1931, pages 116, 170, 172.

Useful data by the head of the Foxboro Flow Meter Department. MFB (2.05)

Coefficients of Discharge of Commercial Metering Elements in 3-inch Pipe. S. R. BEITLER, *Ohio State University Engineering Experiment Station News,* Vol. 3, Nov. 1931, pages 2, 3, 5.

Reports 3-year investigation in co-operation with Bailey Meter Co. of fluid flow through various commercial metering elements in 3- and 6-inch pipe lines, to determine effects of certain influencing factors on the discharge coefficient. Extensive consideration is given to comparative merits of bored and honed orifices. Effect of cadmium plating flow nozzles is also discussed. HO (2.05)

Meter is Check on Intra-plant Losses in Modernizing Bulk Plants. J. C. BENNETT. *National Petroleum News,* Vol. 23, Oct. 28, 1931, pages 118-121, 124.

A "how to" and "why" article. MFB (2.05)

Flow Measurement and Control. M. F. BÉHAR. *Instruments,* Vol. 5, March 1932, page 75, 76.

This installment concludes the mathematical treatment of head meters. 4 graphs, 1 table. MFB (2.05)

Flow Measurement and Control. M. F. BÉHAR. *Instruments,* Vol. 5, April 1932, pages 93-106.

This installment discusses commercially available primary elements of head meters, proposes a "cyclic" classification, compares characteristics of the types, describes a number of commercial devices. 2 graphs, 37 illustrations. MFB (2.05)

Flow Measurement and Control. M. F. BÉHAR. *Instruments,* Vol. 5, May 1932, page 115-126.

This section first concludes the discussion of orifice elements of head meters, and presents in detail the requirements for installation of various primary elements to insure satisfactory metering. 27 figs. MFB (2.05)

"Radial" Gas Meters. *Gas Journal,* Vol. 194, May 13, 1931, page 424.

Has rotary slide valves, removing all longitudinal side thrust and permitting proportionally larger valves in same size case, reducing differential pressure and increasing accuracy of meter. MAB (2.05)

Methods of Determining Gas Well Open Flow Capacities. E. C. CORTELYOU. *Petroleum Engineering,* Vol. 2, May, 1931, pages 170-172.

Advantages and disadvantages of methods of determining open flow capacities. (2.05)

Measuring non-Viscous Liquids by Orifice Meter. W. L. COWAN. *Western Gas,* Vol. 7, May, 1931, pages 62-65.

Continued from April issue. Simplification of the calculation of flow of liquids through orifice meters, with due regard to the various types of gages now in use. (2.05)

Dry Gas Meter Design. J. H. BINGHAM. *Gas Journal,* Vol. 196, Dec. 23, 1931, pages 785-786, and Dec. 30, 1931, pages 836-840.

Extract of a paper presented at a meeting of the Yorkshire Junior Gas Association in Bradford, Dec. 12, 1931. Includes discussion. Fundamental principles underlying the construction and regulation of dry meter. The cycles of operation are followed through carefully and illustrated. MAB (2.05)

Function of Rate and Ratio Controllers. T. B. BURRIS. *Western Gas,* Vol. 7, March 1931, pages 44-46.

Rate of flow and ratio flow controllers have been successfully applied on low pressures, and similar controllers are available up to pressures in excess of 3500 lbs. working pressure. The accuracy of their measurement may be confined to five-tenths of one per cent, providing temperature and pressure corrections are supplied in the usual manner. Illustrated. (2.05)

Air-Flow Gage and Calculator. A. BAUMANN. *Brown Boveri Review,* Vol. 18, Feb. 1931, pages 109-110.

The apparatus described is used to calculate the flow of steam and compressed air produced in electrical energy, gas and water plants. The air meter for a blast furnace blower records the weight of dry air independently of the air pressure, temperature or humidity. MAB (2.05)

Check Meter and Regulator Station Construction. *Petroleum Engineer,* Vol. 2, Sept. 1931, page 80.

The Cities Service Gas Company's check meter and town border station near Atlanta, Kans., is an example of the new of this type of installation in Kansas. (2.05)

Varying-Pressure Flow Meter. AMERICAN ASKANIA CORP. *Instruments,* Vol. 5, March 1932, page 79.

Illustrated description of orifice meter, in which a part of the flow, proportional to the total flow, is converted to atmospheric pressure and temperature and measured by a positive meter. In addition, the rate may be continuously indicated or recorded by a "gage pressure" measuring instrument. MFB (2.05)

Volume Meter for High Pressures. AMERICAN ASKANIA CORP. *Instruments,* Vol. 5, March 1932, page 81.

Description, diagram, cut-out photo, of new instrument for measuring the differential across an orifice by "weighing" the mercury in one leg of a modified U-tube. MFB (2.05)

Adjustable Orifice. BAILEY METER CO. *Instruments,* Vol. 5, May 1932, page 133.

Description, photo, diagram, of new primary metering element giving wide range of capacity. Micrometer adjustment of segmental orifice to 0.001 in. MFB (2.05)

Instrument-Type Liquid-Level Controller. *Power,* Vol. 75, Jan. 12, 1932, page 77.

An instrument-type liquid-level controller designed especially for controlling the levels of liquids of high gravities is illustrated. AHE (2.05)

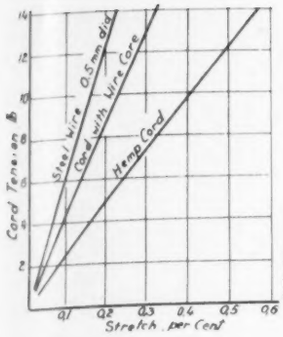

Fig. 54. Chart of Stretch of Cord vs. Load for Various Kinds of Cords, such as Hemp Cord With and Without Metal Reinforced Core. The steel wire is also included for comparison.

straight (not bending) lengths it is better to use steel wire. The stretch of different kinds of cord and metal wire is shown in Fig. 54.

Hooks used for connecting and disconnecting the cord from its drive, and regulating its length, are shown in Fig. 55.

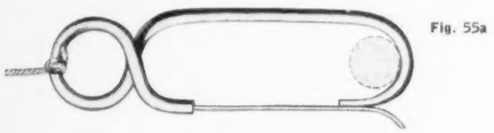

Fig. 55a

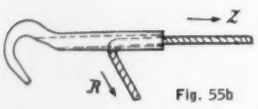

Fig. 55b

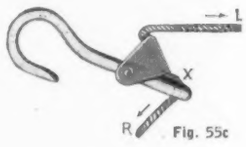

Fig. 55c

Fig. 55d

Fig. 55. Hooks used in engaging and disengaging the drum drive. a) is a catch hook (Maihak) with a flat spring for connecting with the drive crank. b) Maihak and c) Lehmann and Michels serve for connecting two cords and adjusting the length. d) is a release hook (Maihak) which is helpful on high speed engines and reduces the chances of accidents.

◆ ◆ ◆

Instruments Help to Build and Sustain a New Industry

(Continued from Page 209)

A low temperature in No. 1 Chest indicates the use of an excessive amount of fresh diluting water. It is a warning to the head gunner that he should make an effort to substitute as much hot, settled, waste water as possible, since an unnecessarily low temperature results in inefficient and costly operation. Likewise, too high a temperature in No. 2, refined fiber chest, indicates to the machine operator that he is wasting money by heating the stock to a higher temperature than is required.

In addition to the above instruments, which guide the manual control of stock temperatures, two Foxboro automatic temperature recorder controllers stand on guard to control the temperature of the size which is added to the refined stock. The maintenance of a uniform temperature is necessary for the accurate measurement of the size. Day after day the controller maintains a uniform temperature of 150°F. and the perfect circle on the recorder chart is mute evidence that here too instruments help to maintain quality.

Machine and Press Operation

There is little value in controlling the quality in one department if it is allowed to slip in the next. For that reason electric recorders have been installed to check both the machine and press operations. The records are made on the second chart of the twin chart recorder mentioned in connection with the gun operation.

By the use of suitable electric contacts a record is made of each rack of 20 boards turned out by the machines. This record gives a direct check of the number of racks produced and the lost machine time. It also affords a means of determining the machine speed on the basis of racks produced per hour.

The press recorders operate in a similar way. However, they show the loads dried by each press and the drying time of each load. This record is valuable from an operating standpoint since it makes possible the detection of lost time or of cut drying times. Since incompletely dried boards have inferior strength this instrument stands as another sentinel guarding quality.

Masonite Presdwood comes from the presses practically bone dry and must be humidified before shipping. The humidification is accomplished by passing the boards through a long tunnel in which moist air is circulated. Wet and dry bulb thermometers indicate and record the conditions within the tunnel and guide the operators of the air conditioning equipment in the maintenance of the desired humidities.

Checks of the regain are made 6 times each day by weighing a definite number of boards, usually one rack full, before entering the tunnel and then again after their 7 hour trip. Howe platform scales equipped with Weightographs reading to 1 lb., are used for this determination.

Laboratory Instruments

In addition to the instruments used in the mill to guide and control operations a considerable amount of equipment is used in the testing laboratory for the purpose of checking the refining and for determining the physical properties of the finished products. Periodic freeness tests are made on the refined stock to enable the refinermen to produce the desired quality of fiber. The freeness tester, a standard make modified to meet our requirements, has been completely described in an article published in the August 28, 1930, issue of The Paper Trade Journal.

While the freeness tester is used for routine tests, several other types of fiber separators are used for special fiber analyses. A Balopticon is employed for making fiber measurements and shadow pictures of fiber.

The tests to determine weight, caliper, specific gravity and board strength are made with standard laboratory apparatus.

Conclusions

Science is continually bringing out new instruments. Our attention is focused first on one new development and then another and we dream of the day when board weights will be satisfactorily controlled by automatic equipment, when wetlap moistures will be continuously indicated and when the guns and presses may be operated by cycle control equipment. Yet, while we dream of the future the simple pressure gages and thermometers, uninteresting and far from spectacular instruments, continue to guard the quality of Masonite and to guide the operations just as the common stem thermometer did some 7 years ago.

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Correction—New Fuel Governor, August issue, page 201.

The governor speeds should read "1200 R.P.M. or less."

Use of Micropyrometer for High-Temperature Melting Point Investigations. G. R. FITTERER and M. B. ROYER. *Report of Investigations No. 3151, United States Bureau of Mines,* March, 1932, 18 pages.

A recording micropyrometer for the determination of the melting point of refractory oxides is described. It is accurate for determinations using stable compounds, eutectics, and pure oxides. The accuracy is decreased with materials which have wide temperature ranges of solid-liquid immiscibility. 54 references. AHE (2.06)

Controlling Room Temperature Within One-Thousandth Degree. B. F. RANDEL. *Power,* Vol. 75, May 17, 1932, pages 735-736.

Water circulates through all walls, floor and over roof. A drop or rise in the temperature of the return water actuates a mixing valve which admits warm or cold water. AHE (2.06)

A Precision Thermostat for Temperatures from —25° C to 500° C. JAMES A. BEATTIE. *The Review of Scientific Instruments,* Vol. 2, August, 1931, pages 458-465.

Discussions of such factors as the bath fluid, the relative heat capacities of the bath fluid and the apparatus, thermal insulation, stirring, heat supply and automatic temperature control. Descriptions of two thermostats, one for room temperature to 150°C, the other for 150° to 500°C, including many details of construction, wiring diagram and control circuit. Automatic control starts with flat type resistance thermometer primary element, its resistance balanced on a Wheatstone bridge and connected to a mirror galvanometer which initiates on-and-off mode of control by means of a beam of light reflected to one of two photoelectric cells whose change in resistance varies the grid potential of a three-electrode vacuum tube sufficiently to actuate a sensitive relay which in turn actuates the relay that commands the current in the internal heaters. Automatic control through an alternate method is attained by mercurial expansion primary elements actuating relays. Results obtained: the variation in temperature as read on five resistance thermometers placed at various points in the bath was 0.001°C; the variation from place to place even less; the bath temperature increased and decreased with time in a very regular manner, the heating and cooling periods being each about one minute. MFB (2.06)

Self-Balancing Indicating Potentiometer. BROWN INSTRUMENT CO. *Instruments,* Vol. 5, July 1932, page 179.

Brief illustrated description of new instrument. Same self-balancing mechanism and other measuring features as those of original Brown recording potentiometer (see *Instruments,* June, 1931, pages 353-355) but chart and driving mechanism replaced by long scale with easy-reading graduations. MFB (2.06)

Temperature Regulation in Industrial Furnaces. (Temperaturregelung von Technischen Oefen.) M. BUCHTING & C. HIMMLER. *Siemens Zeitschrift,* Vol. 10, 1930, pages 551-560.

Describes the Siemens temperature regulator, its mode of operation, and application to different types of furnace. Ha (2.06)

Electric Thermometers for Grain Silos. (Elektrische Thermometer für Getreidesilos.) W. LIESEGANG. *Siemens-Zeitschrift,* Vol. 12, Jan. 1932, pages 22-25.

The supervision of temperature by remote indication of resistance thermometers is described. Ha (2.06)

The Use of the Tungsten-Molybdenum Thermocouple. *Instrument World,* Vol. 4, Feb. 1932, page 186.

This couple can well be used for temperatures up to 2100° C, but it must be protected from oxidizing atmospheres. The equation of the thermoelectric curve is approximately parabolic of the form $y = cx^n$, where c is a constant and n very nearly equal two. A neutral point exists at about 600° C and the reversal point is at about 1200° C from which point on the usefulness of the couple begins. At 1600° the E. M. F. of the couple is more than 8 microvolts per degree. Ha (2.06)

The Flame Temperature of Mixtures of Methane-Oxygen, Methane-Hydrogen and Methane-Acetylene with Air. G. W. JONES, BERNARD LEWIS, & HENRY SEAMEN. *Journal American Chemical Society,* Vol. 53, Nov. 1931, pages 3992-4001.

The flame temperature of the binary mixtures methane-oxygen, methane-hydrogen and methane-acetylene with air at varying air-gas ratios are given. Flame temperature ranged from 1800 to 2300° C. (2.06)

Control Unit for Refrigerators. GENERAL ELECTRIC COMPANY. *Instruments,* Vol. 5, Feb. 1932, page 59.

This new control unit is designed for controlling the compressor-motor on alternating-current domestic electric refrigerators. Ho (2.06)

Automatic Temperature Controllers. W. C. BEGEEBING. *Petroleum Engineering,* Vol. 3, Nov. 1931, pages 124-125.

Operation of automatic temperature controllers is elaborated on. (2.06)

Use of the Tungsten-Molybdenum Thermocouple. D. BINNIE. *Journal of the Institute of Fuel,* Vol. 5, Feb. 1932, page 211.

Investigated the use of tungsten and molybdenum for measurement of high temperatures, as precious metals have a very short useful life at these temperatures. The junction is not easy to weld properly due to the high melting-points of the metals, but twisting one end of the wire tightly round the other gave satisfactory results. The useful range of the couple is from 1200° C. upwards, the upper limit being the softening point of the furnace refractory material. Use of the couple at high temperatures, and particularly in oxidizing atmospheres, depends on an adequate protecting sheath. High-grade porcelains are claimed to be impervious to gases up to 1750° C., and in the hands of a careful operator there seems to be no reason why accurate temperature measurements up to this point should not be obtained in combustion atmospheres. MS (2.06)

Control for Feed-Water Temperature. H. M. SPRING. *Power,* Vol. 75, Jan. 19, 1932, page 106.

A simple device is described for controlling feed-water temperature automatically by by-passing the heater with enough water to hold the suction temperature at its maximum possible operating temperature. AHE (2.06)

Note on Copper-Constantan Thermocouple Calibration Below 0°C. R. WIEBE and M. J. BREVOORT. *The Review of Scientific Instruments,* Vol. 2, August 1931, pages 450-457.

The authors determined that in order to locate the deviation curve for copper-constantan thermocouples within an accuracy of about 0.05°C, used in connection with the "standard" thermocouple of L. H. Adams, only two points are necessary, namely —78.50°C, the normal sublimation point of carbon dioxide, and —182.97°, the normal boiling point of oxygen. The deviation curve in connection with the data of Adams (International Critical Tables, also A. I. M. E. bulletin 152, 1919) or Southard and Andrews (Journal Franklin Institute 207, 323, 1929) can apparently be represented by the simple quadratic equation, Deviation $= ac+be^2$ with an accuracy of approximately 0.05° C. In order to secure this accuracy with commercial thermocouple wire, each thermocouple must be calibrated individually. MFB (2.06)

A New Temperature-Time Regulator (Ein neuer Temperatur-Zeit-Regler). G. GEROLD. *Stahl und Eisen,* Vol. 51, May 21, 1931, pages 650-651.

Brief description and practical results of a new Siemens & Halske controller whereby and desired temperature-time schedule can be obtained. GN (2.06)

Measurement and Regulation of Temperatures in Metallurgical Furnaces (Ueber Temperaturmessung ung-regelung in metallurgischen Oefen). F. KOFLER & G. SCHEFELS. *Stahl und Eisen,* Vol. 51, Dec. 10, 1931, pages 1529-1535.

Difficulties in continuously measuring the temperatures of metallurgical furnaces successfully overcome by optical measuring methods. Examples include open hearth furnaces, rolling mill furnaces, mixers and rolling mills. Discussion of temperature recorders; their installation, working and recording. 2 references. GN (2.06)

Portable Recording Pyrometer. HOSKINS MFG. CO. *Instruments,* Vol. 5, April 1932, page 110.

Illustrated description of new round-chart, dot-record portable outfit. Self-starting synchronous motor (any 110-volt outlet). Automatic cold-end compensation. Calibration is for Chromel-alumel couples. MFB (2.06)

A New Self-Acting Temperature Regulator. TAYLOR INSTRUMENT COS. *Instruments,* Vol. 5, April 1932, page 108.

Description, clear photo, of remote-bulb, bellows-powered, controller with frictionless stem operation minimizing inactivity differential. MFB (2.06)

Pyrometer Controller. THE BRISTOL CO. *Instruments,* Vol. 5, May 1932, page 127.

Extended description of newly improved "479" line of non-recording pyrometers in which, by means of a knife-edge to knife-edge arrangement, the sensitiveness of the controller equals the sensitivity of the milli-voltmeter measuring system. This basic mechanism now comes in several modifications. One model gives time-temperature process cycles or programs; another differentiates in its corrective action between large and small changes of temperature. A third is a multi-speed anticipatory model. MFB (2.06)

Lamp to Measure Furnace Temperatures. GENERAL ELECTRIC CO. *Instruments,* Vol. 5, May 1932, page 131.

Brief illustrated description of new disappearing-filament optical pyrometer. MFB (2.06)

Steam-Operated Controller. C. J. TAGLIABUE MFG. CO. *Instruments, Vol.* 5, June 1932, page 161.

Description, diagram, of new steam-operated temperature and pressure controller. A differential pressure above and below the diaphragm governs the steam valve opening, this differential depending on a control port operated by thermostatic bellows. MFB (2.06)

Portable Micropyrometer. WESTINGHOUSE ELECTRIC AND MFG. CO. *Instruments,* Vol. 5, June 1932, page 164.

Brief illustrated description of new apparatus combining microscope, gas-tight heating chamber wherein minute sample is placed on platinum strip, radiation receiver and potentiometric recorder. MFB (2.06)

New Universal Thermocouple Head. LEEDS & NORTHRUP CO. *Instruments* Vol. 5, July 1932, page 182.

Brief illustrated description of new accessory to thermocouple installations. Easy accessibility. Keeps out moisture. MFB (2.06)

On Platinum Resistance Thermometry. Part 1. Calibration of Bridge and Annealing of Platinum Bulb. Part 2. Determination of Constants of Platinum Bulb and Accuracy of Resistance Thermometry. MOTOTARO MATSUI and SHUU KAMBARA. *The Journal of the Society of Chemical Industry, Japan,* Vol. 33, Oct. 1930, pages 401B-403B and 403B-407B.

The accuracy of resistance thermometry is 0.01° below 500° and 0.1° above 500°. No reference temperature above 500° is reproducible to 0.01°. Hence resistance thermometry may be said to be the most accurate measurement of temperature at the present time. MAB (2.06)

On Platinum Resistance Thermometry, Part 3. Determination of Low Temperature Scale Between 0° and -190° C. SHUU KAMBARA and MOTOTARO MATSUI. *Journal of the Society of Chemical Industry, Japan,* Vol. 35, Apr. 1932, pages 165B-168B.

The scale is established by using the boiling point of liquid oxygen, the sublimation point of carbon dioxide, and the melting point of mercury. MAB (2.06)

Calibration of Beckmann Thermometer. I. Corrected Eucken's Method. MOTOTARO MATSUI, SHUU KAMBARA, KATSUJI MIYAMURA and AKIRA MIYOSHI. *The Journal of the Society of Chemical Industry, Japan,* Vol. 34, June, 1931, pages 197B-200B.

The corrections and improvements to Eucken's method of the operation of the calibrations were made on the following two Beckmann thermometers: (1) Jena glass 16^{III} Rober Carl No. 19510, P.T.R. No. 100862 certified in 1923, (2) Jena glass 16^{III} V.F.L. Berlin No. 99832. MAB (2.06)

A New Apparatus for Determination of Melting Points. MOTOTARO MATSUI and HIRONDO KATO. *The Journal of the Society of Chemical Industry, Japan,* Vol. 35, Apr. 1932, pages 169B-171B.

Describes and illustrates new apparatus for determining the melting points of metals, and method for using it, as well as its advantages over the Denis instrument. MAB (2.06)

Smoke—A Study of Aerial Disperse Systems. R. Whytlaw-Gray and H. S. Patterson. Longmans, Green & Company, New York, 1931. Cloth, 8¾x5¾ in., 192 pages. Price $4.50.

This book deals with the general and fundamental principles which underlie the behavior of systems consisting of fine particles dispersed in air. It does not discuss the application of the conclusions to technical questions of industrial smokes.

It deals largely with measurements of the number, size, and distribution of the particles, the factors which affect these relations, and the fundamental theories involved. Precise, rather than convenient, methods are used.—H. W. Russell. (12.1) **B**

Thermionic Vacuum Tubes. E. V. Appleton. E. P. Dutton and Company, Inc., New York, 1931. Cloth, 4½ x 6⅞ inches, 117 pages. Price $1.25.

Though this book, due to limited space, does not give a comprehensive treatment of the subject matter, it does, nevertheless, present with surprising completeness, what amounts to, the essential principles and salient features involved in modern thermionic tube theory. Beginning with a discussion on the construction of the modern thermionic tube and on the emission of electrons in the tube, an exact analysis of the internal action of the diode and triode is made, wherein the familiar space charge equations for the diode are developed, and the modifications introduced in them by the insertion of the grid as in the triode are clearly shown. Following this is a masterly discussion on the uses of the triode as an amplifier, rectifier, and oscillator, the text here plainly showing that the author has made an extensive survey of the subjects. The fact that a liberal use of mathematics, including differential equations is made, explains in part the conciseness and profoundness of the treatment. One having a knowledge of the calculus will find no difficulty in gaining a clear understanding of the subject.

This book is of particular value to the beginner because by omitting much extraneous material the author gives him a better opportunity to acquire a firm grasp of the fundamentals; and for a more detailed study he guides him by carefully selecting the references of which there are a generous number at the end of each chapter.—N. Nazar. (5.4) **B**

Indicating the Refrigerating Machine. Gardner T. Voorhees. Nickerson and Collins Co., Chicago. Second, revised edition, Cloth, 4½x7½ inches, 226 pages. Price $2.00

The purpose of this book is to teach the operator of a refrigerating plant, with very little technical education, to take correctly indicator diagrams of an ammonia compressor, to evaluate them intelligently, and to find the faults of the machine with their aid. The first part of the book deals exclusively with this subject and includes useful aids such as tables and charts for adiabatic and polytropic curves, mean effective pressure curves, relative capacity and power curves.

The second part deals with the indicating of the steam engine and is based on the well known instruction book of the Crosby Steam Gage and Valve Company on indicating practice. It describes in minute detail the function, construction and operation of the engine indicator and the interpretation of the indicator diagram in steam engine practice.

The third part contains descriptions of a number of commercial indicators such as the Crosby, Thompson, Tabor and Trill, as well as of various kinds of stroke reducing motions and planimeters.

Miscellaneous tables and charts such as properties of saturated ammonia vapor and of saturated steam, numerical tables, and several conversion tables useful for the engineer, constitute the fourth part of the book.

While the primary object of the book seems to be attained, it is regrettable that in the revision of the former edition it was not brought more up to date.—K. J. De Juhasz. (2.09) **B**

Physics. A. Wilmer Duff, Editor. P. Blakiston Co., Philadelphia, 1932. Cloth 5½ x 8½ inches, 681 pages. Price $4.00.

The seventh and latest edition of this well known textbook of physics has just come off the press. It is written for students of science and engineering. The sixth edition has the distinction of having been completely reproduced and has appeared in China, lacking only the name and address of a publisher.

This text put out by P. Blakiston Co. of Philadelphia is unique in that a group of six eminent teachers of physics in America have collaborated to produce this very sane, well-balanced and unified textbook of Physics. In fact, the unity of the text is the more remarkable because of the number of authors. This unity has doubtless been secured in part by the various revisions it has undergone over the long term of years it has been in the market.

Compared with a dozen other modern textbooks of Physics, this text has been very lavishly illustrated. In the mind of the reviewer, illustrations help very much in the clearer understanding of the subject matter of the text.

Dr. A. Wilmer Duff, Professor of Physics in the Worcester Polytechnic Institute of Worcester, Mass., has not only served as editor of the entire text, but is also author of the first section dealing with Mechanics and Properties of Matter, and a second section on Sound. Of the 681 pages of the text, 156 are devoted to Mechanics and Properties of Matter—nearly one fourth of the text. This is as it should be, for Mechanics lies at the foundations of all the subjects studied under the title of Physics. For the subject of Sound, Professor Duff has reserved only 34 pages. General Physics cannot be entirely covered in a one year course and must be cut somewhere. Sound is as good a place as any in which to condense and it has been done very successfully under Professor Duff's pen.

The reviewer would like to express his own appreciation of the order of subject matter which Professor Duff has chosen for the section on Mechanics. There is a sequence which can be wisely chosen so that the student arrives progressively at various subjects with a background prepared for those subjects. There has been of late too much of a tendency among physics textbook writers to put the cart before the horse.

Geographically, Professor Duff selected his co-authors in a well balanced fashion. With himself holding down the Atlantic seaboard, Professor Duff extended his reach and brought in Professors Birge and Hall from the University of California to look after the Pacific coast line and discuss the two topics, Wave Motion and Light. These topics in previous editions were supervised by the late Professor E. Percival Lewis of the same institution. The subject of Wave Motion is so important in various fields of physics and allied subjects that it deservedly occupies 23 pages of text. The future student of alternating currents should certainly be conversant with these pages.

Those two authors devote 130 pages to the subject of Light. One could question whether this subject might not have been scaled down a little, and yet when one thinks of the relation this subject bears to the fields of modern physics, there is no argument. Wise selection of what to discard is more difficult than the selection of what should go in a modern textbook of Physics.

Returning once more to a geographical consideration of the authors—if three men were necessary for the western slopes of the Rockies and the eastern slopes of the Alleghanies, surely three more were necessary for that vast territory drained by the "Father of Waters." Dr. Charles E. Mendenhall, Professor of Physics in the University of Wisconsin is the author of the subject of Heat. One hundred pages are devoted to its consideration. Since this is a text for future engineering students, Dr. Mendenhall takes up the subject of Thermodynamics in a very thoroughgoing fashion. This subject with its relations to the hydrogen scale of temperatures is one with which future steam, and particularly heat, engineers will wish to become intimately familiar.

Emeritus Professor of Physics Albert P. Carman of the University of Illinois and his colleague, Dr. Charles T. Knipp, Professor of Experimental Electricity, cover the fields of Electricity and Magnetism, Conduction of Electricity through Gases, and Electromagnetic Phenomena in general. They occupy 203 pages out of the total 681 pages. In spite of the modern tendencies to fill pages on the subject of radio, these authors have been very conservative, and wisely so, from the viewpoint of the reviewer. It would seem much more important for a student of electricity to know something about resistance, capacitance, and inductance before trying to understand radio in all its ramifications.

The mechanical get-up and the appearance of the book on the outside are excellent. As one opens the book, however, in spite of its numerous illustrations, the reviewer feels that it is lacking that intangible something which, in a book possessing it, causes the one skimming through its pages, without even reading a word, to say to himself, "This looks interesting," or "I want to read this more carefully." For his own benefit, the reviewer wishes he knew just what that element is which causes a book to do this sort of thing.

The body of the text contains a great variety of tables of constants and physical properties. This makes the book very useful in the solution of the well selected problems. It means that the student has everything he needs for the solution of the problems between the two covers of the book. The problems which have been selected are placed at the end of each main topic, rather than a small group at the end of each chapter. The problems which accompany the main text are indicated by subject headings.

These six authors set out to write a text book of physics for students of science and engineering. In the estimation of the reviewer, they have succeeded admirably.—S. R. Williams. (12.1) **B**

Electron Tube Handbook. (Lehrbuch der Elektronen-Röhren). H. Barkhausen. Verlag S. Hirzel, Leipzig, 1931. 6 x 9 inches, 171 pages. Price 7.5 RM.

The new edition is a complete treatise on the theory and application of tubes in the widest sense. It gives in a lucid and very concise manner the theory of tubes with and without grids, starting with the elementary laws of electron movement, explaining the impulse ionization in the vacuum and its measurements, the electron emission of hot metals and the space charge current. The electron entrance into metals and the action of magnetic fields close the first chapter. The second part is devoted to the tubes with grids. In this chapter one encounters again the unfortunate lack of an international agreement on certain significant technical terms. The conception of "Durchgriff" which is defined as the measure how many times weaker the anode voltage acts on the emission current than the grid voltage, can be adequately rendered only with difficulty, perhaps best by "grid ratio" as the arrangement of the grid with respect to the anode is determining for this action. This characteristicum of a tube is particularly well treated. The closing paragraph of this chapter shows on several numerical examples how well the behavior of technical electron tubes can be determined from their dimensions, just as simply as an electrical machine can be calculated. The last chapter deals then with the theories of the various connections according to the purpose for which the tubes are used, as amplifiers, generators of alternating current or oscillations, or as rectifiers. The comparatively small volume of 167 pages has accomplished what is usually given in more elaborate treatment; the principal rules and conclusions from the theory in each section are printed in italics and give in this manner a brief, easily found expression of the important points. Numerical examples and especially the very well chosen diagramatic illustrations contribute to the easy digestion of this not often simple subject, the more so as the reader is expected to be familiar with at least the mathematics of alternating current phenomena. The print and general makeup of the book invite to study.—M. Hartenheim. (5.4) **B**

(Continued on Page A15)

Heat and Combustion (2.07)

Heat Meters. (Wärmemengenmesser.) H. Netz. *Archiv für Wärmewirtschaft und Dampfkesselwesen*, Vol. 12, Dec. 1931, page 345.
Comparison of principal types. MAB (2.07)

New Automatic Combustion Indicator. *Gas Age Record*, Vol. 69, Jan. 1932, page 64.
Illustrated description of Hays Corporation's new instrument designed to provide continuous indication of CO_2; CO_2 and furnace draft; CO_2, furnace and uptake drafts; and CO_2, furnace draft and flue-gas temperature. WAT (2.07)

Automatic Combustion Indicator. *Power*, Vol. 74, Dec. 22, 1931, page 913; Vol. 75, Feb. 23, 1932, page 281.
An instrument using the Orsat principle of operation and which provides continuous indication of CO_2; CO_2 and furnace draft; CO_2, furnace and uptake draft; and CO_2, furnace draft and flue gas temperature is illustrated. AHE (2.07)

The "How" and "Why" of the Throttling Calorimeter. Lawrence Washington. *Power*, Vol. 75, March 29, 1932, pages 472-473.
Explanatory. AHE (2.07)

Automatic Combustion Control Extended to New Section. *Power*, Vol. 75, May 31, 1932, pages 809-810.
Steam pressure at the Hudson Ave. station of the Brooklyn Edison Co. is regulated by an automatic combustion control system which varies the gas flow from and coal feed to the stokers. Control of the coal feed to the stokers of units 1 to 6 and of the forced-draft pressure of units 1, 2 and 3 is obtained by varying the speed of d.c. motors, which are on a Ward Leonard control system. The gas flow from the furnaces is varied by control of the outlet damper, there being no induced-draft fans. The air-duct pressure and suction at the induced-draft fans of unit 4 are controlled by speed variation of wound-rotor motors which drive the forced- and induced-draft fans. On Nos. 5 and 6 the air-duct pressure is controlled by varying the position of vanes at the inlets of single-speed motor-driven forced-draft fans. Gas flow for the induced-draft fans, driven by 2-speed induction motors manually controlled is regulated in a manner similar to the air-duct pressure. Regulation of units 7 and 8 is tied integrally with the control of 4, 5 and 6 units through master control equipment and the oil pumps and compressors which comprise the motive power for regulation. The master control includes 4 "supermaster" regulators (2 actuated by the steam pressure and 2 by hand) and a supermaster gage box. Each row of high-pressure boilers (4-8) has its own "section master." The steam-pressure-actuated supermasters translate changes of steam pressure into changes of air-loading pressure, which are distributed by means of an air tunnel to the various section masters. By means of a throw-over cock at each section master, control can be switched to manual operation. AHE (2.07)

Automatic Combustion Control at Leicester Electricity Works. *The Steam Engineer*, Vol. 1, June 1932, pages 378-383.
Variations in steam pressure regulate the fuel and air supply to the boilers. The Bailey control is described and its operation explained in detail. AHE (2.07)

New Automatic Combustion Indicator. C. J. Tagliabue Mfg. Co. *Instruments*, Vol. 5, April 1932, page 110.
Description, photo, diagram, of new model Mono Duplex mechanical Orsat which automatically takes samples of flue gas, analyzes them for Co_2 and unburned gases, and indicates and records the results. MFB (2.07)

Automatic Control Adjusts Air to Mixed Gases. Karl A. Mayr. *Power*, Vol. 75, Jan. 12, 1932, pages 63-64.
An apparatus is described and illustrated which automatically proportions air to the heating value of changing mixtures of 2 gases. This system may find application to boiler furnaces using 2 fuels simultaneously. (2.07)

Automatic Combustion Indicator. *Power*, Vol. 74, Dec. 22, 1931, page 913.
For applications that do not require graphic records for checkup and analysis, the Hays Corp. has developed a new automatic combustion indicator which shows CO_2; CO_2 and furnace draft; CO_2, furnace and uptake drafts; and CO_2, furnace draft and flue gas temperature. AHE (2.07)

Orsat Gas Analyses. (Orsat Gas-Analysen.) Olof Rodhe. *Archiv für Technisches Messen*, 1931, section V723-4, page T86.
The analyzer consists of several pipettes in which the constituents of a passing combustion gas, CO_2, O_2, CO, H_2 and CH_4, are absorbed respectively by suitable absorption liquids. The accuracy of this apparatus is 0.01 to 0.05%. Eighteen references are cited. Ha (2.07)

Impervious Tubes of Pure Alumina. Frank Adcock & Donald Turner. *Journal Scientific Instruments*, Vol. 7, 1930, page 327.
Small tubes of pure alumina about 1/10 in. diam., and 1/20 in. bore, have been glazed externally in an oxy-hydrogen flame. Such tubes are practically impervious to gases at room temperature, and are suitable for refractories above the temperature (about 1600° C.) for which "Pythagoras Material" can be used. Ha (2.07)

A New Tester of Combustion Gases. (Ein neuer Rauchgasprüfer.) *Electrotechnik & Maschinenbau*, Vol. 49, Aug. 16, 1931, pages 632-633.
This instrument absorbs carbon-dioxide by potassium-hydroxide and indicates both CO_2 and unburned gases. The construction of the instrument, made by "Duplex-Mono," Hamburg, is described in detail. Ha (2.07)

The Paterson "Chloroscope." *Iron & Coal Trade Review*, Vol. 122, June 19, 1931, page 976.
The addition of one part of chlorine per 2,000,000 parts of water is required to prevent entirely all non-conductive organic growth on the surface of the condenser tubes; in this way the best economy of operation of steam turbines is maintained because of the maintenance of the full vacuum. The chloroscope is a small portable instrument to make very rapid and accurate determinations whether any slight excess of chlorine is present in water for power station work or other general applications. It contains tubes of glass colored yellow so as to correspond to known amounts of excess chlorine for comparison with the yellow color given when a solution of orthotolidine is added to water containing free chlorine. The instrument is manufactured by the Paterson Engineering Co., London. Ha (2.07)

Humidity and Moisture (2.08)

Air Conditions and the Comfort of Workers. *Metropolitan Life Insurance Company Policyholders Service Bureau Report No. 5*, Feb. 1932, 20 pages.
Human beings can do four times as much work in a temperature of 100°F. when relative humidity is 30% than when it is 100% and perform at maximum efficiency between temperature limits of 40° and 75° F. Report describes simple methods of measuring humidity and air motion, and explains how air is "conditioned" for comfort and efficiency. Methods of removing excessive heat and moisture, and of cleansing the air are also described. (2.08)

Air Conditioning for Low Humidity with Silica Gel. J. Wells and L. G. Wade. *Power*, Vol. 75, March 22, 1932, page 429.
An entirely automatic air conditioning system is described, consisting of silica gel absorbers, activation furnace, air-circulating fans, air filters, coolers and control systems. All air is cleaned in electrically operated filters. The silica gel beds pass through 4 cycles; 4 dampers are activated by compressed-air pistons whose movement is controlled automatically by an electric clock driving a cam which closes a Hg switch starting a small motor driving 4 cams controlling the compressed-air valves. AHE (2.08)

Printers' Moisture Indicator. Cambridge Instrument Co. *Instruments*, Vol. 5, April 1932, page 107.
Describes small, portable device with blade-like hygrometric element for measuring the moisture content of piled or stacked paper. Scale is calibrated in % relative humidity. 2 photos. MFB (2.08)

Saturation Recorder-Controller. *American Gas Journal*, Vol. 136, Jan. 1932, pages 59-60.
The TAG saturation recorder-controller is described. CBJ (2.08)

Thermo-Hygrometer. (Thermohygrometer.) L. Schira. *Glas und Apparät*, Vol. 12, Aug. 23, 1931, pages 137-138.
This instrument measures the relative and absolute humidity, the dew-point and the deficiency in saturation; all these quantities can be read directly on curves on the scale. The temperature is given by a thermometer. The capillary of this alcohol thermometer controls the movement of the scale of the instrument so that the curves show values which are correct for the respective temperature. The accuracy of the instrument is ± 2%. Ha (2.08)

Electrical Humidity Meter. (Elektrischer Feuchtigkeitsmesser.) *Elektrotechnische Zeitschrift*, Vol. 53, March 17, 1932, page 266.
The instrument is of the type of the aspiration psychrometer the principle of which was developed by Regnault in 1853; electric thermometers are used, and the current is measured by cross-coil instruments in bridge connections. The arrangement is described in detail. Ha (2.08)

New Hygrostat. Barber-Colman Company. *Instruments*, Vol. 5, Feb. 1932, page 59.
This hygrostat is an inexpensive instrument for controlling humidifying apparatus by electrical means. It is essentially an automatic two-way switch operated by changes in the length of a wood cylinder as it reacts to changes in atmospheric moisture content. HO (2.08)

Power, Work and Output (2.09)

Torque Dynamometer. Toledo Scale Co. *Instruments*, Vol. 5, June 1932, page 163.
Brief illustrated description of new dynamometer designed for high speed production testing of electrical starting motors. MFB (2.09)

Efficiency of Concrete Mixing Recorded by Wattmeter. Ira A. Butcher. *Engineering News-Record*, Vol. 108, June 23, 1932, pages 885-886.
Recording wattmeter gives useful data on mixing operation, progress of pour and delays, and shows changes of mix since changing the mix changes the power required. Illustrative charts are explained. CBJ (2.09)

A Piezo-Electric Method of Measuring the Pressure Variations in Internal Combustion Engines. H. G. I. Watson & D. A. Keys. *Canadian Journal of Research*, Vol. 6, Mar. 1932, pages 322-331.
Piezo-electric gage records explosion pressures of an internal combustion engine as displacements of the beam of a cathode-ray oscillograph. By applying a time displacement to the beam, synchronizing with the speed of the engine so as to cause a displacement at right angles to the pressure displacement, the time-pressure characteristics of the engine explosions are obtained on a photographic film. Inertia effects thus minimized, the gage provides records of a single cycle in the investigation of knocks. Specimen records, 9 diagrams and 1 table. OWE (2.09)

Pull-Meter on Entirely Hydraulic Principle. (Rein hydraulisch arbeitender Zugkraftmesser.) K. Marks. *Zeitschrift Verein deutscher Ingenieure*, Vol. 75, Dec. 19, 1931, pages 1540-1541.
The difficulties of measuring the draw-bar pull especially in agricultural machinery are explained and a new instrument described which uses as a measure for the average pull the quantity of a liquid flowing in a definite time from a pressure cylinder through a capillary; the result can be recorded continuously. The construction of the instrument and the mathematical principle is explained. Ha (2.09)

Physical Properties (2.10)

Machine Tests Corrosive Action. *Power*, Vol. 75, May 3, 1932, page 661.
An apparatus for alternately immersing a solid in a liquid and exposing it to the air is briefly described and pictured. AHE (2.10)

Control for Heating Effect of Gases. *Power*, Vol. 73, March 24, 1931, page 495; Vol. 75, Feb. 23, 1932, page 310.
This flame analyzer measures, records and automatically controls the heating effect of any gas. AHE (2.10)

Salt Spray Corrosion-Test Chamber. American Instrument Co. *Instruments*, Vol. 5, May 1932, page 135.
Brief illustrated description of new apparatus in which the 4% sea-salt solution is prevented from striking the specimens directly. MFB (2.10)

Fundamentals of Electricity and Magnetism. Leonard B. Loeb. John Wiley & Sons, Inc., New York, 1931. Cloth. 6x9 inches, 432 pages. Price $4.00

In this book Professor Loeb has gone against established tradition regarding college physics texts and has also produced an excellent work. Here is a text written by a physicist expressly for engineering students, in a manner which shows a sincere appreciation of the problems which confront such men in their introduction to the subjects of electricity and magnetism.

In several respects are the author's efforts commendable. First, he stresses the physical principles underlying all physical phenomena covered in the text, and has endeavored to make use of mathematical developments in relating these phenomena to their fundamentals. Whereas most books treat the subject (for such students) purely qualitatively, in this text everything is on a firm quantitative basis. Second, a point particularly interesting to the engineering student, he has placed great stress on units and dimensions. He considers two classes of units—fundamental and derived, the former defined directly in terms of fundamental concepts and the latter derived from these. The three systems of units in which these quantities are expressed are discussed in a way which eliminates many of the causes of confusion usually present. Considerable stress is placed upon dimensional balancing of equations. Third, and probably most important, is the excellent historical treatment of the subject. There is a general discussion of the development of physical science and a more detailed story of the development of the fields of electricity and magnetism. This provides an excellent background and places in proper perspective the work which is to be later considered.

The book is written in a clear and forceful as well as interesting manner and is up to date in all respects. The author has included, wherever possible, modern atomic and electronic theory in explaining the more complex phenomena such as electrolysis and the electric cell. It may be considered too modern in one respect at least, for the author has included a discussion of the modern physical developments far beyond the understanding of the students for which the book is intended. Thus parts of the two chapters at the end of the book on Discharge through Gases and Atomic Structure, and The Photoelectric and Thermionic Effects are to be so considered. However, for one who has mastered the preceding chapters of the book, these latter define a huge field of application of fundamental physical principles of great scientific and engineering interest.

The book includes a variety of excellent problems and a rather complete table of units and dimensions.—D. Silverman. (4.1) **B**

Handbook of Geophysics. (Handbuch der Geophysik.) Vol. VI. H. Reich, H. Hunkel and E. A. Ansell. Varlag Gebruder Borntträger, Berlin, 1931. Cloth, 8¼ x 5½ inches, 312 pages. Price RM 63.

This sixth volume of the Handbuch will probably be of greatest interest to the readers of this journal, as it deals with instruments and methods used in geophysical prospecting. The first part of it which is now available covers the physical properties of minerals and rocks, a portion of the gravitational methods, and the electrical methods of prospecting.

After an introductory chapter on the principles, classification and range of application of geophysical methods, a thorough discussion is given of such properties of minerals, rocks and formations which are of importance in the interpretation of geophysical effects, to wit: specific gravity, elastic properties, electrical conductivity, magnetic properties, and dielectric constant, radioactive and thermal properties. A great number of tabulations are given covering most of the material which has been published thus far; this chapter represents probably the most complete account on physical properties of rocks which is at present available.

The next section on electrical methods of prospecting deals with (1) methods using spontaneous polarization; (2) methods using extraneous currents; (3) and methods using high frequency radiations. In view of the great importance which resistivity methods have attained lately (about seventy articles have appeared on this phase of electrical prospecting during the past four years) the results obtained by the use of this method in civil engineering and in structural and ore prospecting might have been stated in greater detail. The account of the theory of the potential distribution in homogeneous and inhomogeneous ground for direct and alternating current is well presented, and followed by a description of the equipotential and potential profile method.

The third section of the book deals with the theory of relative gravity determinations, especially the theory of various factors, like flexure of the support, etc., affecting the results. The theory of the torsion balance is derived, and a description of instrument types is given. Formulae for the computation of the gradients and curvatures are presented, and methods for terrain correction are discussed.

The fourth and last chapter of the book is devoted to a description of instruments and methods for pendulum observations, with a rather complete account of the theory of various corrections, a topic which is covered to some extent also in the third chapter of the book. Valuable information is given on the computation of pendulums, on the determination and computation of corrections, coincidences, time signals, etc. A number of figures illustrate the most important types of pendulums and pendulum apparatus now in use.

The second part of the sixth volume of the Handbuch will contain the last installment on the gravity instruments, a section on magnetic prospecting, a section on seismic prospecting, and a review of other less important methods. —C. A. Heiland. (10) **B**

The Balancing of Machinery. C. Norman Fletcher. Emmott & Co., Ltd., London, 1931. Cloth, 8½x5½ inches, 172 pages. Price 10s.

This book is distinctly a valuable adjunct to the library of any mechanical engineer interested in the practical question of machine balancing. The material of this book premises for its intelligent use the thorough understanding of the theoretical aspects of mechanical balance and as the author expressly states, "supplies the need for practical information by giving in a comparatively simple practical form a résumé of the factors affecting balance, together with a description of the better-known apparatus now available for detecting unbalance, as well as the methods and calculations involved in the actual correction of bodies which are shown by the equipment to require it."

Without doubt, the author has collected the material for his book mostly from the commercial literature of the various balancing machine manufacturers, but has so tempered it with leavening co-ordination and reference to the theoretical aspects of the subject, that a distinct character is given the presentation.

The dynamic balancing machine is given its proper attention, filling up 60 pages of the book, 30 being devoted to the static balancing machine and the remaining 75 to general principles, special purpose balancing machines, and the practical correction of balance.

A single omission is to be regretted, but possibly occurred because of its recent announcement—the automatic balancing machine of the General Electric Company. This machine uses an old principle pointed out by LeBlanc in 1890; that a rotating body is self centering if run above its critical speed. The General Electric device constitutes the first application of this principle to the balancing of machinery.

The author could have quite appropriately discussed the question of field balancing, since with large machines of several tons weight and increasing flexibilities, field balancing is becoming more important, balancing in machines in the shop taking on more and more the nature of preliminary balance.

The book bespeaks a real familiarity with the subject of balancing machines and, as such, is a welcome publication. —M. Stone. (6.2) **B**

Introduction to Modern Physics. F. K. Richtmeyer. McGraw-Hill Book Co., Inc., New York. 1928 (Fourth Impression.) Cloth, 9¼x6¼ inches, 596 pages. Price $5.00.

Although four years have passed since this book was published, a fourth printing has just made its appearance. Evidently, then, the appeal of this book is not based upon its treatment of current developments but rather upon its presentation of the origin and development of modern physical theories.

The first section of the book is devoted to an historical survey dating from the earliest times to the last decade of the nineteenth century. This historical sketch provides an interesting and convenient source for the knowledge which gives the correct perspective for viewing present-day developments in the science.

The survey is followed by the developments in physics beginning with the discovery of photoelectricity. Although all the branches of the science are not treated in this work, e. g. wave mechanics is omitted, nevertheless the subjects taken up are well presented. Because of the broad scope of the book an attempt to include all branches would have led to a presentation at once sketchy and difficult to read. Reference to original sources and papers are given at appropriate points throughout the text rather than lumped at the end of each chapter. Vector analysis is not used in this book.

As the title states the book is an introduction to modern physics. It cannot be considered to replace the specialized treatises which exist in the various branches of modern physics. To one who has already been introduced to the concepts of, say, the electromagnetic theory, a more rigorous and orderly presentation will be found elsewhere. On the other hand, to one who has a knowledge of elementary physics and the calculus, and who is making a first acquaintance with the subject matter of modern physics, this general treatise is a valuable book on the subject.

The Methods and Means of Electrical Measurement. (Elektrotechnische Messkunde.) Dr.-Ing. P.B. Arthur Linker. Julius Springer, Berlin, 1932. Cloth, 8¼ x5½ inches, 619 pages. Price RM 31.50.

To translate the word "Messkunde" as "measurements" would in the case of this book not be adequate; electrical metrology would render the exact meaning better, for not only are measuring methods described, but instruments, apparatus, auxiliary devices, diagrams of connections and theoretical principles are explained thoroughly and with an abundance of references to the magazine and other literature. The book starts very properly with the definition of absolute and relative measurements and explains the possible errors due to observation or instruments. The first chapter, almost half of the whole book, describes the electrical measuring methods for resistance, insulation measurements, temperature coefficients, voltages, current, output, capacity, inductance, thermocouples, batteries, and instrument transformers. The second chapter deals with magnetic measurements, where particularly the ballistic methods and the demagnetizing influence of the ends of rods are treated very lucidly. Direct-current measurements on d.-c. machinery form the subject of the third chapter, and the last chapter covers the vast field of alternating current measurements for resistances, synchronous and asynchronous machinery, rectifiers, and the taking of alternating current curves. The analysis of harmonic curves and oscillations in the last section is very complete in describing the different principles employed, but the apparatus for doing it is treated a little scantily, and one has to look in the literature for which plenty of references are cited. A very valuable appendix is the table of natural constants of the elements and more often employed alloys, as it contains the most recent values available. The volume is, as usual with books of this publisher, well printed and made up, and is not only for the laboratory but is also quite useful for the man in the test room or in the field, as the most modern devices, including the electronic, are considered.—M. Hartenheim. (4.1) **B**

A Simplified Apparatus for Determining the Deviation of Gas from Boyle's Law. PHILIP E. BECKMAN. *American Gas Journal*, Vol. 136, March 1932, pages 20-23, 34-35.

Description and discussion of the operation of an apparatus for testing natural gas for its deviation from Boyle's Law. The apparatus differs from that of the Bureau of Standards type in design but conforms in principle whereby a volume of high pressure gas is expanded and metered at or near atmospheric pressure, the ratio of the metered gas volume to that expanded volume indicated by Boyle's Law giving a super-expansibility index or deviation factor. The formulas and mathematical steps for evaluating expressions involving the given conditions to solve for Y, the super-expansibility deviation factor, are given in detailed steps. The article includes a discussion of the calibrating of the apparatus, typical results from its use, a photograph of the setup, and a diagram of the apparatus. CBJ (2.10)

The Plastometer: A New Instrument for Measuring Plastic Properties of Coal. JOSEPH D. DAVIS. *Industrial Engineering Chemistry, Analytical Edition*, Vol. 3, January 15, 1931, pages 43-45.

Presented before the Cincinnati meeting of the American Chemical Society, Sept. 1930. Description of the plastometer and of the method of making test are given. MEH (2.10)

Some Observations on the Dilation of Several Common Steels. H. E. PUBLOW, C. M. HEATH, & M. E. BATCHELOR. *Bulletin No. 41, Michigan Engineering Experiment Station*, Dec. 1931, pages 3-15.

Several tests were made on steel cylinders with the Chevenard dilatometer from which the authors conclude that in many cases the dilatometer gives a better means of detecting critical points in metals than the thermal type of instrument; a closer control of the heat treatment is possible. Further, steels which have not been fully annealed will often react differently under the influence of heat in the same bar, which can be detected by the warping and twisting produced in them. Complete annealing eliminates this effect. Case-carburized steel if slowly cooled from the carburizing heat and then hardened by quenching from just above the lower critical point, will have the least tendency to shrink or warp. The dilatometer is recommended as it easily detects all slight changes and internal reaction at different temperatures. Ha (2.10)

Determination of the Viscosity of Tar, Pitch, and Similar Opaque Substances. D. C. BROOME & A. R. THOMAS. *Journal Society Chemical Industry*, Vol. 50, Nov. 13, 1931, pages 424T-428T.

It has become increasingly evident that the present system of testing tars, bitumens, oils, and similar materials, purely from the standpoint of existing tar or bitumen practice, is inadequate in gauging their true characteristics. Describes and illustrates an apparatus for that purpose. (2.10)

New Hardness Testers. *Instrument World*, Vol. 4, Feb. 1932, page 195.

Brief description of the Rockwell direct-reading hardness tester, especially for use with ferrous and non-ferrous metals; and the Duroskop which is depending on the dynamic principle of a falling pendulum and can be used on all kind of materials also to measure resiliency. It is a portable instrument. Ha (2.10)

Measuring and Controlling the Consistency of Slips and Glazes. WALTER L. SHEARER. *Ceramic Age*, Vol. 19, Feb. 1932, pages 68-70.

Two instruments, plastometers, are described which permit, by three stop-watch readings, to determine the deflocculation and plasticity of any slip used in ceramics. Ha (2.10)

Portable Brinell Hardness Tester. R. Y. FERNER Co. *Instruments*, Vol. 5, Jan. 1932, page 26.

A new hardness testing instrument, based on the Brinell principle of making an impression on the metal to be tested by applying a known load to a steel ball of a given diameter. The instrument is portable, and can be used anywhere in the shop where a drill press, a vise, or other means of applying pressure is available. HO (2.10)

Surface Tension Balance. ROLLER-SMITH Co. *Instruments*, Vol. 5, 1932, page 23.

Essentially the instrument is a 1000 milligram balance with a parallel scale calibrated in dynes per centimeter. HO (2.10)

A Simple Hardness Tester. (Ein einfacher Härteprüfer.) HUETTER. *Oberflächentechnik*, Vol. 9, Jan. 5, 1932, pages 2-3.

The instrument tests the hardness of a galvanic deposit by a scratch with a glass-hard steel point or diamond point under which the sample is pulled along. The point is pressed against the sample with 50g, 100g, or more according to the material. The width of the scratch is determined in 1/1000 mm. and serves as measure for the hardness. Although very simple the instrument gives consistent results, for instance, for the same pressure it was measured on

rolled lead	144μ	copper sheet, hard	48μ
rolled tin	76μ	hard rolled brass	36μ
duralumin, hard	56μ	nickel sheet	34μ

The hardening effect of cobalt in nickel deposits could be easily measured, the value of 34 went down to 20 at 75% Ni and remained constant to 100% Co. Ha (2.10)

Freezing Point Measurement of Bituminous Materials by the Hoepfner-Metzger Method. (Starrpunkt-Bestimmung bituminöser Stoffe nach Hoepfner-Metzger.) K. A. HOEPFNER. *Archiv für Technisches Messen*, 1931, section V9215-2, page T87.

Very viscous materials which do not pass directly from the liquid into the solid state but become gradually more and more viscous and finally solid offer difficulty in determining the exact point of solidification. The method consists in cooling the mass to be tested about 10° below its assumed solidification point and then slowly heating again whereby a weight of 450g of 0.5 mm. diameter presses on the mass. The depths of penetration are read from degree to degree, and by plotting the time-penetration depth curve the point can be determined where the depth was 1/10 mm; this point is considered to be the "H-M solidification point." The temperatures are measured by a thermocouple placed in the mass. The procedure is described in detail. Ha (2.10)

Determination of the Consistency of Bituminous Substances. K. A. HOEPFNER-DANZIG. *Revue Pétrolifère*, Oct. 31, 1931, pages 1361-1366.

Description of various methods of the physical analysis of bituminous substances. (2.10)

Investigations of the Heat Conductivity of Refractory Bricks. (Untersuchungen über das Wärmeleitvermögen feuerfester Steine.) ANTON KANZ. *Mitteilungen aus dem Forschungsinstitut der Vereinigte Stahlwerke Akt.-ges. Dortmund*, Vol. 2, No. 10, 1932, pages 223-234.

An improved method of measuring the heat conductivity of refractory materials in the form of a thin plate is described which has the advantage of compensating for heat losses. The arrangement is fully described and the results of a great number of silica, corundum, bauxite, chromite and other bricks are tabulated. The values found agree very well with those determined by more complicated methods. Heat conductivity of silica bricks increases with increasing temperature. Other refractories showed below 300° C. irregularities probably due to structure changes. It is recommended to investigate the refractory properties more closely in the range between 100 and 600° C. 13 references. Ha (2.10)

Investigation of the Method of Determining the Relation of Statical Hysteresis and Flexural Stress by Measurement of the Decrement of a Freely Vibrating U Bar. G. H. KEULEGAN. *Bureau of Standards Journal of Research*, Vol. 8, May 1932, pages 635-656.

To determine whether measurements of the decrement of a vibrating U bar could be used to measure with sufficient accuracy the statical hysteresis of a given material. The statical hysteresis of a U bar of Armco iron was first measured under cyclic static loading, and then the decrement of the vibrations of the same material was measured. The results of the experiment showed that within the limits of the accuracy of the approximate theory used, both methods gave equivalent results. For stresses above a certain small threshold value, it was found that in Armco iron the energy lost by statical hysteresis varied approximately as the cube of the amplitude of the maximum stress. WAT (2.10)

The Total Heat and Specific Heat of a Series of Petroleum Oils, and Their Relation to Other Properties. H. R. LANG & R. JESSEL. *Journal Institution Petroleum Technologists*, Vol. 17, Sept. 1931, pages 572-576.

Deals with the preparation of the samples and the determination of their mean molecular weights and other properties; the temperature variation between 0°C. and 100°C. of the specific heat; and the total heat of the liquids. (2.10)

The Shape of the Tensile Test Bar for Cast Iron. J. G. PEARCE. *Bulletin British Cast Iron Research Association*, Vol. 3, April 1932, pages 86-88.

The standard tensile test bars in Great Britain, America and Germany are described and compared and a series of systematic tests with a material of a definite analysis were made to find the influence of the shape of the samples on the strength. Conclusions are that there is no regular variation in strength with grip length, nor with gage length, variations probably being due to the material itself. Ha (2.10)

Liquid Level (2.11)

Fluid-Level Indicator. *Power*, Vol. 73, Feb. 17, 1931, page 308; Vol. 75, Feb. 23, 1932, pages 282-283.

General. AHE (2.11)

Oil-Level Control for Machine Bearings. *Power*, Vol. 73, April 21, 1931, page 643; Vol. 75, Feb. 23, 1932, page 300.

Descriptive. AHE (2.11)

Liquid-Level Controller. *Power*, Vol. 73, May 19, 1931, page 792; Vol. 75, Feb. 23, 1932, pages 307-308.

Descriptive. AHE (2.11)

Water-Level Control for Low-Pressure Boilers. *Power*, Vol. 74, Aug. 18, 1931, page 250; Vol. 75, Feb. 23, 1932, page 308.

Descriptive. AHE (2.11)

Water-Lever Televisor. *Power*, Vol. 74, Sept. 1, 1932, page 338; Vol. 75, Feb. 23, 1932, page 283.

Electrodes making contact with the boiler water are connected to a distributor containing a transformer and a set of relays of the magnet-coil, double-pole, Hg-contact type. The indicator is an arrangement of red and green lights. AHE (2.11)

Water Gage with Condensate Guide. *Power*, Vol. 74, Sept. 15, 1931, page 406; Vol. 75, Feb. 23, 1932, page 266.

Descriptive. AHE (2.11)

Liquid-Level Stabilog. FOXBORO Co. *Instruments*, Vol. 5, June 1932, page 161.

Description, photo, diagram of new liquid-level controller, made in 2 types giving 2 distinct modes of control—(1) "throttling" and (2) "averaging." MFB (2.11)

"No-Water" Stop for Centrifugal Pump. *Power*, Vol. 74, Nov. 3, 1931, page 654; Vol. 75, Feb. 23, 1932, page 310.

When the suction line is full of water the float chamber also is full of water and the float holds the steam valve wide open. Should the water recede, the float drops and closes the steam valve. AHE (2.11)

Mechanical Boiler Water Level Indicator. *Power*, Vol. 75, Jan. 26, 1932, page 148; Feb. 23, pages 265-266.

In modern power plant boilers of large capacity the water gage is a considerable distance above the operating floor. To provide a reliable indicator so located that it can be observed readily by the boiler operator, displacement weights in the alarm water column operate (through a stainless-steel chain) a movable plunger in a flat glass gage on the floor level. A remote instrument can be operated by attaching an iron core to the chain and mounting an induction coil externally. AHE (2.11)

Boiler Water Level Recorders and Indicators. *Steam-Plant Engineering*, Vol. 1, Feb. 1932, page 53.

The Bailey boiler water level recorder operates on the difference in level obtained by making 2 connections to the water column or boiler drum, 1 to the water space and the other to the steam space where a constant water head is maintained in the connection by means of a steam condensing radiator and a reservoir. AHE (2.11)

INSTRUMENTS INDEX

Of instruments and devices for measurement, inspection or control

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Depth
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R. Y. Ferner Co.

TESTING & INSPECTION (3)

Physical Testing and Inspection (3.1)

Sockets of Low-Melting Alloy Best for Wire-Rope Test Samples. D. H. Corey and E. T. Cope. *Engineering News-Record*, Vol. 108, May 5, 1932, page 652.

Samples of wire rope socketed with spelter broke near the sockets and gave low tensile strengths. From the location of the breaks it was thought the skin hardness, resulting from cold drawing of the wire in manufacture, had been decreased at the pouring temperature of the spelter, about 1000° F. Alloys of low melting point were investigated. When samples were socketed with 83-7-10 lead-tin-antimony alloy—pouring temperature 500-650° F., better tensile strengths were obtained and location of failures indicated that the full strength of the rope was being developed. CBJ (3.1)

Cool-Room Cement Testing Necessary at Arizona Highway Laboratory. J. W. Powers. *Engineering News-Record*, Vol. 108. Feb. 25, 1932, page 297.

Design and construction of cold room, moist closet, and storage tank. (3.1)

Apparatus for Testing of Lubricants. *Power*, Vol. 73, Feb. 17, 1931, page 308; Vol. 75, Feb. 23, 1932, page 301.

Machine shows effects of different lubricants on certain types of transmissions, also gives relative efficiency of different bearing metals under various conditions of load, speed and temperature. A mandrel is mounted in 2 antifriction bearings arranged to hold it rigidly in alignment. The test block is a piece of metal ½x½x¾ in. hardened to Rockwell C-60 and ground. It is inserted in a notch in the loading lever and held in place by a wedge. AHE (3.1)

Journal Oils Undergoing Extensive Tests for Suitability. *Transit Journal*, Vol. 76, March 1932, page 155.

Photograph and short discussion of a specially designed car journal oil-testing machine installed by the Standard Oil Company at its research laboratory at Bayonne, N. J. A comprehensive research program is outlined. CBJ (3.1)

New Gigantic Testing Machine. Richard Rimbach. *Instruments*, Vol. 5, Feb. 1932, pages 44-46, A21.

Machine recently completed by Baldwin-Southwark Corp. for California Institute of Technology is described. Capacity is 4,000,000 lbs. load in compression, 3,000,000 lbs. in tension. Can accommodate specimens up to 33½ ft. in length. Special features are: Hydraulic application of load; load is not applied by screws between cross-heads, as these serve only to locate cross-heads. Compression tests are carried out between lower cross-head and table; tensile tests are made between upper cross-head and the yoke around lower cross-head. Provision is made for an elevator to bring assistants to any level for extensometer readings, and all controls are concentrated at an instrument board. Control refinements, powering equipment, and calibration accessories are described. HO (3.1)

The Present Status of Possibilities of Diascopic X-ray Tests. (Der gegenwartige Stand Rontgendiaskopischer Prüfungs moglichkeiten.) H. Reininger. *Werkstattstechnik*, Vol. 25, May 1, 1931, pages 225-230.

The principles of translucency for X-rays are discussed and apparatus for this simplest method of X-ray testing in the shop described. A list of 30 references is added. Ha (3.1)

X-ray Crystal Analysis. J. Cadogan Rothery. *Electrical Review*, Jan. 8, 1932, page 48.

Review of a report issued by an X-ray Committee under the chairmanship of Sir William Bragg, appointed by the Department of Scientific and Industrial Research. Deals with application to non-metallic substances, examination of tungsten magnet steels, and investigation of electrolytic deposits of metals. MS (3.1)

Ultraviolet-Radiator for Testing of Materials. (Ultravioletstrahler für Stoffprüfung.) L. J. Busse. *A E G -Mitteilungen*, Feb. 1932, pages 63-64.

An analyzing quartz lamp is described which emits only dark filtered ultra-violet rays. In the light of such rays especially organic materials become fluorescent; the fluorescence is related to the physical and chemical structure of the material and can serve to test the purity of materials. Ha (3.1)

Air Corps Uses New "Aging Test" for Aviation Fuels. *National Petroleum News*, Vol. 23, Nov. 4, 1931, pages 29-30.

Test consists of heating a sample of motor fuel in oxygen bomb under 95-100 lbs. pressure oxygen for 4 hours at about boiling point of H_2O, then oxidized sample is evaporated in glass dish. (3.1)

Paper Testing, Some Schopper Instruments. *The Instrument World*, Vol. 4, March 1932, pages 207-208.

Describes a few instruments and machines applicable for mechanical tests of paper; tensile testing machine of the pendulum type with safety arrangement against the pendulum swinging back at rupture of the paper; a Schopper-Dahlen bursting tester, a rapid tester, etc. Ha (3.1)

Magnetic Testing of Pipe Welds is New Inspection Method. H. R. Simonds. *Steel*, Vol. 88, March 5, 1931, pages 39-42.

A magnetic testing outfit built by the Ferrous Magnetic Corporation, New York, is described for magnetic and X-ray testing, photographs are shown and the defects pointed out. Ha (3.1)

Distribution of Tension in Welded Joints With Special Regard to Boilers. (Spannungsverteilung in Schweissverbindungen unter besonderer Berücksichtigung des Kesselbaues.) Kochendoerfer. *Autogene Metallbearbeitung*, Vol. 25, Jan. 1, 1932, pages 5-12.

The distribution of tension in butt-welds was determined by means of the laminar flow pictures of Hele-Shaw. A quantitative evaluation of the pictures is, however, not possible, it shows merely the danger spots of a joint. The actual course of the tensions can be determined by photo-elastic methods, from which then the most favorable profile of a butt-weld can be theoretically developed. The procedure is described and photographs of flow pictures reproduced. Ha (3.1)

Production Testing and Inspection (3.2)

Reo Cuts Inspection Costs by Using New-Type Gages. *Iron Age*, Vol. 129, Jan. 14, 1932, pages 179-180.

For outside diameter of piston pins a new 5000:1 visual gage is actuated by a shadow which is magnified by passing through two condensing lenses. In the anvil of the gage is a strip of tungsten carbide, while on the end of a spindle is mounted a diamond. For connecting rod bores, indicator gage provides a three-point contact. Crankshaft main bearings are checked by a Zeiss passameter caliper gage. Outside diameter of valve tappets is measured by a Sheffield electric indicator gage. For checking thread profiles and matching odd shaped surfaces a J. & L. Hartness comparator is employed. VSU (3.2)

Gage for Continuous Sheet Stock. Pratt & Whitney Co. *Instruments*, Vol. 5, March 1932, page 84.

Illustrated description of continuous-gaging electrical-amplification machine, an adaptation of the "Electrolimit" gage which gives a 1 in. meter deflection for 0.0001 in. variation in thickness of the material rolled. MFB (3.2)

Gas Leak Tester for Vacuum Tubes. Lepel High Frequency Laboratories. *Instruments*, Vol. 5, May 1932, page 134.

Description, photo and diagram of new instrument whereby the gas in the bulb is excited into glowing by radio frequency currents. MFB (3.2)

Test for Smoothness of Machined Surfaces. F. A. Firestone, F. M. Durbin and E. J. Abbot. *Metal Progress*, Vol. 21, No. 4, April 1932, pages 57-59.

Pointer moving over surface carries mirror reflecting point-light and providing 400:1 or 500:1 photographic record. WLC (3.2)

Modern Shop Methods for Testing, with Particular Reference to Optical Automatic Precision Instruments. (Neuzeitliche Werkstattmessverfahren unter besonderer Berucksichtigung optischmechanischer Prezisioninstrumente.) O. P. van Steewen. *Das Werkzeug*, Supplement to *Maschinenkonstrukteur-Betriebstechnik*, Vol. 7, Sept. 10, 1931, pages 177-180; Nov. 10, 1931, pages 193-197.

Describes gages, the Hirth Minimeter, optometers, microscopes, pitchometers, gear testing apparatus, etc., etc. MAB (3.2)

Electro-Limit Comparator. Pratt & Whitney Company. *Instruments*, Vol. 5, Feb. 1932, page 53.

This new comparator is an electrical gage. It comprises a cast-iron base carrying an anvil and a column supporting the measuring head, and has a capacity of 4 in. The standard magnification of the circuit will cause the needle to travel about 7/16 in. for each 0.0001 in. variation in the sizes of the parts gaged. Ho (3.2)

Dynamic Balancing in the Quantity Production of Small Motor Armatures. (Serienvorichtung von Kleinmotorenankern.) W. Spaeth, *Elektrotechnische Zeitschrift*, Vol. 53, Jan. 14, 1932, pages 30-32.

An arrangement is described for the dynamic balancing of small rotating parts in mass production. The problems of dynamic balancing and the methods for doing it are discussed. In small armatures the most convenient way of balancing is the placing of small strips into the slots of the armatures. The machines used for balancing have dials which show where to place additional weight. Ha (3.2)

The Interpolation Method in Routine Detonation Testing. Donald B. Brooks. *S. A. E. Journal*, Vol. 30, Jan. 1932, pages 54-56.

The author discusses the permissible interpolation interval for use in routine detonation testing as affected by octane number, engine, and adjustment of the bouncing-pin apparatus. Test results presented show that, with suitable adjustment, the use of a 10-unit interval does not materially reduce precision although it greatly reduces the time and the quantities of materials needed for the test. To determine an economical and practical method of suitably adjusting the bouncing-pin regularly and rapidly for the use of large interpolation intervals will require further research. Ha (3.2)

Measurements in Quantity Production. (Messungen im Austauschbau.) G. Erndt. *Archiv für Technisches Messen*, 1931, section V83-0, pages T53-54.

In order to safeguard the exchangeability of parts produced in quantity tolerances are specified which have to be strictly observed. The fundamentals and definitions of units and the technical measuring system are explained and the errors due to observation and to measuring instruments discussed. The importance of the German DI-standards is pointed out. Ha (3.2)

New Means for the Production of Accurate, Particularly of Large Threads. (Neue Hilfsmittel zur Erzeugung von genauen, insbesondere von grossen Gewinden.) P. Nichterlein. *Feinmechanik und Präzision*, Vol. 40, Feb. 1932, pages 23-29.

Three new measuring instruments are described for checking, during manufacture, the diameter, profile and thread, using a thread profile microscope, thread tester, and diameter caliper. The instruments and their applications on the cutting lathe are described in detail. Ha (3.2)

A New Gear Tester. *Automobile Engineer*, Vol. 21, Dec. 1931, page 595.

A new gear testing device for testing the accuracy of involute gear teeth. Made by Messrs David Brown & Sons Ltd., Huddersfield. Register within 0.0001 in. Simplicity of action and design is found throughout so that this accuracy can be consistently maintained. RHP (3.2)

Maintenance Testing and Inspection (3.3)

Involute Gear Testing Instrument. *Engineering*, Vol. 133, Jan. 1, 1932, page 22.

The instrument, made by David Brown and Sons, Ltd., Huddersfield, is intended for checking of repetition work and is useful for testing special types such as master gears, etc., up to 12-in. It indicates directly on a dial a deviation of .0001 in. from the correct involute shape. LFM (3.3)

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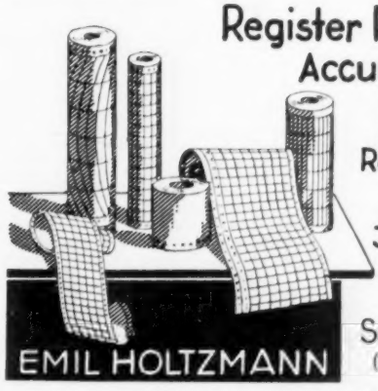

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ELECTRICITY & MAGNETISM (4)

Electrical Properties, Tests, Measurements, and Measuring Instruments (4.1)

Composite-Coil Electrodynamic Instruments. FRANCIS B. SILSBEE. *Bureau of Standards Journal of Research*, Vol. 8, Feb. 1932, *Research Paper 411*, pages 217-264.

New type of electrodynamic instrument. The principles of operation and the limitations in the accuracy both of ordinary wattmeters and of the new type of instrument are discussed in detail. An experimental ammeter of the new type, having a range of 5 amp. and readable to 0.01% is described. Equations on which the design of this type is based are worked out, and the design of a wattmeter carried through. Appendices contain the more mathematical portions of the design, discussion of temperature errors, suggestions as to winding coils so that two independent windings will have very nearly equal magnetic effects. WAT (4.1)

A New Megohm Meter. (Ein neues Megohmmeter.) W. JAEKEL. *Feinmechanik und Präzision*, Vol. 40, Feb. 1932, pages 31-33. See *Instruments*, Vol. 5, April 1932, page A12. Ha (4.1)

Capacity Measurement. (Kapazitäts-Messung.) GEO. KEINATH. *Archiv für Technisches Messen*, 1931, section V3532-1, page T11.

The range of technically employed capacities lies between $1x10^{-6}$ and approx. 100 microfarads. The principles of the methods are explained. Ha (4.1)

Measurement of the Electrical Conductance of Non-Metallic Pipe Coatings. E. R. SHEPARD. *American Gas Journal*, Vol. 136, June, 1932, pages 22-26.

Measuring coating conductance is more difficult than measuring conductance of a metallic circuit or an electrolyte. It has 3 components, due to large holes, to capillaries, and to inherent conductance. Any factor which changes or moves the electrolyte within the capillaries is likely to affect materially the total conductance of the coating, which therefore, is indefinite and unstable. A complete description of the d.-c. test set for measuring coating conductances as well as a discussion of the technique of field measurements is given. CBJ (4.1)

A New Method of Measuring Contact Potential Differences in Metals. W. A. ZISMAN. *The Review of Scientific Instruments*, Vol. 3, July 1932, pages 367-370.

A new method is described for measuring the contact potential differences between dissimilar metals. It enables one to measure the p.d. to 1/1000 volt in a few seconds of manipulation. An apparatus is described for studying metals in air and another is described for high vacuum work. (4.1)

Megohm Decade Resistance Box. SHALLCROSS MFG. CO. *Instruments*, Vol. 5, April 1932, page 110.

Description, 2 figs., of new device with an unusual resistance range of megohms. Another feature is that the binding-post arrangement permits using it as a potential divider. MFB (4.1)

Multi-Range Voltmeter and Milliameter. SHALLCROSS MFG. CO. *Instruments*, Vol. 5, April 1932, page 107.

Describes new combination multi-range instrument for a.c. and d.c. Comprises a measuring circuit using a number of resistors in conjunction with a universal meter. Photo and diagram. MFB (4.1)

New Shielded Ratio Box For Impedance Bridges. LEEDS & NORTHRUP CO. *Instruments*, Vol. 5, April 1932, page 109.

Describes new instrument for high precision a.c. measurement. May be used either with one point grounded, or with a Wagner earth connection. MFB (4.1)

Portable Potentiometer. GRAY INSTRUMENT CO. *Instruments*, Vol. 5, May 1932, page 131.

Brief illustrated description of new precision instrument. MFB (4.1)

Multirange Direct Reading Conductivity Meter. SENSITIVE RESEARCH INSTRUMENT CORP. *Instruments*, Vol. 5, May 1932, page 128.

Description, photo, diagram, of new compact portable field instrument for measuring resistance from 5 ohms to 500 megohms. MFB (4.1)

Rail Joint Tester. HARTMAN & BRAUN A. G. *Instruments*, Vol. 5, July 1932, page 182.

Brief description, with photo and 2 diagrams, of new device, operable by one man, easily portable. MFB (4.1)

Graphic Instruments. ESTERLINE-ANGUS CO. *Instruments*, Vol. 5, July 1932, page 181.

Brief illustrated description of the new line. Among innovations are interchangeable clock units; all 3 springs in clock wound at 1 time by a crank; means of coupling all chart rolls to assure synchronism; complete assortment of electrical synchronous motor clocks. New line comprises 22 different instruments. MFB (4.1)

Testing Methods for High-Tension Insulators. (Méthodes d'essais pour isolateurs à haute tension.) O. STEELS & G. MARYSSAEL. *Revue Générale de l'Électricité*, Dec. 19, 1931, page 979-984.

Describes tests carried out on insulators having originally three shells, to which was added a supplementary shell after the striking of arcs which were produced in service on a 50,000-volt line. Outlines the application which was made of Regereis' method for the qualitative determination of the flow lines and equipotential surfaces. Describes the potentiometric set-up for determining the value of the potential of the characteristic points of the insulator surface. This set-up is a simplification of the one proposed by H. J. Ryan in 1916. MS (4.1)

Measurements by Means of Liquid Helium, XI. Resistance of Pure Metals at Low Temperatures. (Messungen mit Hilfe von flüssigem Helium XI. Widerstand der reinen Metalle in tiefen Temperaturen.) W. MEISSNER & B. VOIGT. *Annalen Physik*, Series 5, Vol. 7, 1930, pages 761-797; 892-936.

Almost all metals were tested between 1.2° and 273° absolute and the resistances given. The tests lead to the conclusion that the metals mercury, indium, thallium, thorium, tin, lead, tantalum and titanium, and eventually ruthenium, and viobium, become supra-conductive; rubidium, zirconium, vanadium arsenic and antimony show a tendency to supra-conductivity and should, therefore, be investigated below 1.2° abs. Tables of characteristic temperatures arranged according to the periodic system are given. Ha (4.1)

Electrical Measuring Devices and Applications (4.2)

Electrical Instruments Uncover Hidden Shop Losses. A. G. BAUMGARDNER. *Iron Age*, Vol. 128, Dec. 17, 1931, pages 1537-1542, 1584.

Discusses absorption dynamometers (Prony brake, hydraulic and fluid friction brakes, fan brakes, electro-magnetic and electric brakes); transmission dynamometers (levers, torsion and cradle types), and describes various applications of electrical instruments in machine tool field. VSP (4.2)

Recording Demand Watt-Hour Meter. *Power*, Vol. 74, Oct. 6, 1931, page 513; Vol. 75, Feb. 23, 1932, page 295.

Descriptive. AHE (4.2)

Small Measuring Bridge. *Power*, Vol. 75, Jan. 12, 1932, page 76; Feb. 23, 1932, page 295.

Descriptive. AHE (4.2)

The Electrical System-System Protection. H. W. COLLINS & K. J. MAKINEN. *Detroit Edison Synchroscope*, Vol. 18, Oct. 1931, pages 264-268.

A general description of how relays are used and arranged in the protection and detection of faults in the Detroit Edison transmission network. Ha (4.2)

Current Transformers. (Stromwandler.) GEO. KEINATH. *Archiv für Technisches Messen*, 1931, section Z283-1, page T62.

Various types of construction with the particular view of compactness are described especially types built closely together with or even within the high tension porcelain insulator; the later type is the bushing transformer. The kinds of insulation for the core and oil is described. Ha (4.2)

A Galvanometric Method of Measuring an Electrolytic Resistance. J. A. C. TEEGAN. *Philosophical Magazine and Journal of Science*, Series 7, Vol. 11, June 1931, pages 1250-1252.

The telephone used for determining the balance of the bridge was replaced by an inductance and capacitance in series, the galvanometer can then easily and sharply be adjusted to the minimum deflection while the adjustment of a telephone to minimum sound is too indistinct. An example is given. Ha (4.2)

Precision Wire Resistances for Direct and Alternating Current. (Präzisions-Drahtwiderstände für Gleich-und Wechselstrom.) JOS. KROENERT. *Archiv für Technisches Messen*, 1931, section Z111-1, pages T78-79.

The principal properties of a precision resistance are temporal constancy, lowest temperature coefficient, smallest capacity, smallest self-induction and smallest capacity against earth. The means to obtain these ends are discussed and various materials suitable for such resistances are described. Twenty references are cited. Ha (4.2)

A Clock-Controlled Constant-Frequency Generator. A. B. LEWIS. *Bureau of Standards Journal of Research*, Vol. 8, Jan. 1932, pages 141-157.

A synchronous motor generator set is described in which the motor is forced to rotate in synchronism with signals from a standard clock circuit. This result is obtained by first running a specially wound motor synchronously from a 3-phase power line. The field of this synchronous motor is then electrically rotated about the motor frame by an amount which exactly compensates for the departure of the frequency of commercial power from true 60 cycles. This rotation of the motor field is produced by a rotating synchroscope which is in turn controlled by thyratron tubes, the grids of which are excited by a clock-driven tuning fork. The output of the generator is used to operate cycle counters, synchronous timers, or other light synchronous machinery. The possibilities and limitations of the machine are discussed and data are given to indicate the accuracy ($\pm$0.004 second) which may be expected from the machine when used as a timing device. Safety devices are described which shut down the machine should it for any reason fall out of synchronism with the clock signals or hunt excessively. The machine has an ultimate load capacity of 4-kw, and can take a suddenly applied load of 2-kw without serious hunting. WAT (4.2)

Variable-Ratio Voltage Control for Industrial-Plant Transformers. A. G. DARLING & A. PALME. *Power*, Vol. 74, Dec. 22, 1931, pages 894-897.

Among the common conditions which can be modified or corrected by load ratio control are: (1) Variable secondary voltage caused by variations in the primary voltage as created by physical changes in the primary circuit; changes in loading of the primary circuits; and changes in wattless current in the primary circuit; (2) Variable secondary voltage due to changes in loading of the secondary circuits; changes in wattless current in the secondary load circuits; and changes in the distribution of wattless current between secondary- and primary-voltage sources of power. Several G.E. outfits are described and illustrated. AHE (4.2)

Stroboscopic Device for the Oscillograph and Its Application to the Investigation of the Screening Effect of Currents. (Stroboskopische Vorrichtung zum Oszillographen und ihre Anwendung zur Untersuchung der Stromverdrängung.) A. MOSKWITIN. *Archiv Elektrotechnik*, Vol. 25, Sept. 10, 1931, pages 631-640.

The distribution of the current in the conductors of a slot of an electrical machine and the magnetic leakage are made visible by a stroboscopic arrangement which also shows very clearly the phase difference in the currents of the various conductors. Two methods are devised, one uses a real stroboscopic disk driven by a synchronous motor of the frequency of the current to be oscillographed, the other a little pendulum between the poles of a permanent magnet and excited by a frequency of the same order as the current has. Both disk and pendulum interrupt the light ray of the oscillograph so that the oscillogram shows the time and space distribution of the current in one single picture. The tests confirm that the current in the bottom part of a conductor has a phase lag of considerably more than 90° against the current in the upper part. The oscillograph in this modification is particularly able to determine quickly the circle diagram of an alternating current motor. Ha (4.2)

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Magnetic Measurements (4.3)

The Problem of the Rotating Magnet. JOHN ZELENY & LEIGH PAGE. *Physical Review*, Vol. 40, Apr. 1932, pages 299-306.

In the rotating magnet angular actions and reactions are equal and opposite insofar as the mechanical separable parts of the mechanism are concerned but do not occur in equal and opposite pairs between the electrically separable elements of the system. In systems of this type the magnetic field serves merely as a non-mechanical intermediary for the interaction of the two parts of the mechanical system. The analysis of the problem of the rotating magnet previously given by the authors is extended. For the special cases considered, it is shown that, while the magnet exerts equal and opposite torques on the portions of the current circuit inside and outside of the magnet, neither of these portions individually exerts any torque on the magnet itself. The analysis is applied also to the case where the magnet is replaced by a solenoid, and to the case where the magnet is replaced by a brass cylinder and the flux through it is supplied by an outside coaxial solenoid. WAT (4.3)

Testing for Magnetic Characteristics. B. E. STEVENS. *Bell Laboratories Record*, Vol. 10, March 1932, pages 261-265.

Describes how B-H curves of magnetic materials are taken and brings out their importance for providing information on suitability of materials for relays, transformers, etc. Ha (4.3)

Sensitive Magnetic-Material Detector. CENTRAL ENGINEERING LABORATORIES. *Instruments*, Vol. 5, June 1932, page 163.

Description, photo, of new device for detecting concealed tools or weapons. Principle — proximity of steel, etc., changes earth's magnetic field through coil, deflects mirror galvanometer, activates photocell, actuates relay, operates alarm. MFB (4.3)

Precision Measurements of the Gap Flux Density in Moving-Coil Magnets. C. E. WEBB. *The Wireless Engineer & Experimental Wireless*, Vol. IX, No. 101, Feb. 1932, pages 67-69.

Flux measurement is carried out by the standard method of moving a search-coil through the field and noting the deflection produced on a ballistic galvanometer connected to the coil. Method described has following advantages: (1) Use of sensitive ballistic galvanometer allows a search-coil of only one turn to be employed, and this admits of more precise location of the circumferential area within which the flux is measured. (2) Use of a single coil which can be accurately located in any desired position in the gap gives greater flexibility than is obtainable with differential coils. (3) By taking a series of readings and plotting a curve, the uniformity of the field within the length of gap under test can be explored, and the actual value of flux density at each point can be determined instead of the mean value over a considerable length. (4.3)

Contribution to the Study of the Magnetometer. (Contribution à l'étude du magnétomètre.) H. PECHEUX. *Revue Générale de l'Électricité*, Dec. 26, 1931, pages 1019-1024.

Develops an equation for calculating the magnetic mass of a magnet from the measurements made with a Weber magnetometer. Discussion of the results obtained in a numerical example brings out the optimum conditions of measurement. MS (4.3)

The Testing of Permanent Magnets. (Einiges über die Prüfung von Dauermagneten.) A. GAIER. *Elektrotechnische*, Vol. 52, Aug. 27, 1931, page 1124; *Telegraphen und Fernsprech Technik*, Vol. 19, 1931, page 187.

The field of a permanent magnet is compared with that of a permanent magnet of known field strength by placing it around the movable coil of a moving coil instrument; if both give the same deflection for a certain current in the coil their fields are the same. Ha (4.3)

Measuring Core Loss at High Densities. B. M. SMITH & C. CONCORDIA. *Electrical Engineering*, Vol. 51, Jan. 1932, pages 36-38.

Modern electrical machines work at much higher iron fluxes as were formerly employed, going as high B=20,000 Gauss. The Epstein-method which is the standard in almost all countries requires a sine wave form of voltage across the magnetizing coil, and gave sufficiently accurate results for the standard induction of B=10,000. For very high flux densities, however, great errors are made due to the distortion of the flux wave, a large flux in the test coil and a low power factor. The new method modifies the measurement by using an induction coil over the magnetizing coil and feeding the usual R. M. S. voltmeter and a flux voltmeter by it. The theory of the method of determining the maximum flux density regardless of its wave is based on the following: (1) the maximum alternating flux density is proportional to the arithmetic average value of the induced voltage regardless of the wave form of the voltage, and (2) if an alternating voltage rectified without changing the wave form is impressed on a moving-coil B.C. voltmeter, the instrument indications are proportional to the arithmetic average value of the rectified wave. The necessary equipment and connections are described and curves of different steel sheets up to 19,000 Gauss are reproduced showing that in some silicon steels the magnetization curve shows a reversal at about 16,000. This method is recommended as standard in order to base guaranty losses on densities more nearly equalling actual values. Ha (4.3)

Measurement of Iron Losses in the Epstein-Apparatus by the Alternating Current Bridge. (Messung der Eisenverluste im Epsteinapparat mit der Wechselstrombrücke.) W. HOHLE. *Archiv Elektrotechnik*, Vol. 25, Dec. 1931, pages 813-823.

The mathematical expressions for several electric connections of the alternating current bridge for the measurement of iron losses are developed. It is found that the distortion of the wave form influences the results considerably, but for measurements up to 12,000 Gauss with only slight wave distortion as it is usually the case in large alternators, the error is negligible. Ha (4.3)

ELECTRONICS & RADIO (5)

Radio Measurements (5.1)

Field-Intensity Measurements at Frequencies From 285 to 5,400 Kilocycles Per Second. S. S. KIRBY & K. A. NORTON. *Bureau of Standards Journal of Research*, Vol. 8, Apr. 1932, pages 463-479.

Radio field intensities were measured at distances of only a few wave-lengths from the transmitting station on a wide range of frequencies, including the broadcasting band, in order to determine the distance at which ground absorption became appreciable. At a distance of 2.4 km. there was no appreciable absorption for frequencies below about 1000 kc; above this frequency, the absorption became appreciable and increased as the frequency was increased. Daylight measurements made at greater distances on broadcasting frequencies, airways phones and airways beacons show that field intensities fall off to 1% of what the inverse distance law with no absorption would give at distances from 100 to 400 km, depending on the frequency and on the nature of the ground. The experimental data were compared with Rolf's attenuation graphs in order to determine the electrical constants of the land east and west of the Allegheny Mountains. East of and including the mountains (Maryland, Pennsylvania, and New Jersey) the conductivity and dielectric constants were found to be 3.35×10^{-14} e.m.u. and 13, respectively; west of the mountains (near Chicago) they were found to be 1.07×10^{-13} e.m.u. and 13, respectively. Using these constants theoretical values of field intensity were graphed for these two types of ground and for the broadcasting frequencies. The experimental data were also compared with results given by the Austin-Cohen transmission formula. It was found that for overland transmission in the range of frequencies observed this formula did not satisfactorily give the variations in field intensity as the distance was changed or as the frequency was changed. WAT (5.1)

The Calculation of Detection Performance for Large Signals. J. P. WOODS. *Physics*, Vol. 2, Apr. 1932, pages 225-241.

The plate detection performance of a tube having a given curve for its static characteristic can be calculated from the extended power series which represents the characteristic. The power series analysis of the curve is obtained from a Fourier series analysis by a method which saves labor, is more accurate than that of simultaneous equations, is applicable to the tube alone, to a circuit containing the tube and external resistances, and may be applied to any similar non-linear receiving system. WAT (5.1)

Applications of Radio to Measurement and Control (5.2)

Meteorograph with Wireless Transmission. (Meteorograph mit drahtloser Fernubertragung.) H. KIRSTEN. *Zeitschrift Verein Deutscher Ingenieure*, Vol. 76, Jan. 30, 1932, page 104.

The balloon instruments often get lost with their records. A combination instrument built by the Askania works is described which emits radio signals whereby the temperature, barometric pressure and humidity can be recorded on a terrestrial station: the 3 measuring instruments are connected to 3 fixed points over which a rotating contact moves. Ha (5.2)

Ultra-Micrometer Measurement by Radio. H. OLKEN. *Instruments*, Vol. 5, Feb. 1932, pages 33-36.

A minute change in distance between plates of a condenser produces a considerable change in the condenser capacity. Combined with the extraordinary sensitivity of radio methods for measuring changes in condenser capacity, this affords a means of measuring inconceivably small distances.

The "present state of the art" in these radio ultra-micrometers is presented. They are classified into Dowling, resonance, heterodyne and other methods, the principles of operation explained, circuit diagrams given. Includes illustrations of industrial application and a considerable bibliography. HO (5.2)

The Radio Tester. (Der Radioprüfer.) *Elektrotechnische Zeitschrift*, Vol. 53, Jan. 7, 1932, pages 18-19.

A portable instrument for testing radio receiving sets for defects; measuring range 5 to 1000 volts, 50 milliamps to 5 amp., and 2500 to 1,000,000 ohms. Ha (5.2)

Recent Radio-Meteorographic Methods. (Neue radiometeorographische Methoden.) P. DUCKERT & B. THIEME. *Elektrotechnische Zeitschrift*, Vol. 53, Mar. 24, 1932, pages 297-298.

A small tube emitter of 1 to 2 watts sends waves of 20 to 60m. in length and weighs only 400g; it is provided with a contactor in the anode circuit to give signals and can be sent up in registration balloons. A quartz crystal dependent on the air pressure controls the apparatus. The ground station receives the signals and can evaluate the signals from the change of the wave-length emitted by the quartz crystal. Ha (5.2)

Photo-electric Measurements, Devices, and Applications (5.3)

Where is Television? A. P. PECK. *Scientific American*, Vol. 146, May 1932, pages 284-285.

The status of television today may be summed up as follows: If a person is content to see pictures that are not even comparable with the early movies, then television is a reality. If, however, one is interested in something comparable with a home movie outfit, television is no reality and probably will not be for some time to come. WAT (5.3)

On The Photo-electric Cell. M. G. SAY & C. R. MAGUIRE. *Journal Royal Technical College (Glasgow)*, Vol. 2, Jan. 1932, pages 680-688.

Outline of underlying theory of photo-electric cells; account of an investigation to develop photometric measuring device employing the photo-cell as a detector, as first part of an attempt to develop a photo-electric method of adequate simplicity for the photometry of electric lamps. WAT (5.3)

Spectrometry (7.5)
Photography (7.6)
Microscopy (7.7)
Electromagnetic Rays (This heading covers all electromagnetic rays other than visible light: infra-red, heat rays, ultra-violet, X-rays, alpha, beta, gamma, cathode, and cosmic rays.) **(7.8)**

CHEMISTRY (8)
Under this heading will be chemical measurements, analysis, and their control applications.

ASTRONOMY, NAVIGATION, AVIATION (9)
Included in this section will be, besides usual matters concerning astronomy, navigation and aviation, special matter on direction-control such as range finding, direction finding, radio beacons, etc.

GEODESY, GEOLOGY (10)
In this section will be covered seismology, geophysical prospecting methods, etc.

INSTRUMENT DESIGN and CONSTRUCTION (11)
Matters concerning new instruments, their design, operation and manufacture, will be included under this heading.

GENERAL and MISCELLANEOUS (12)
This section will include: First; general items of interest to all in the field of measurement and control. Example—"Possibilities of Vacuum Tubes for Application to Measurement and Control" is an article of universal interest in the fields of measurement and control. Second; miscellaneous items of general interest because not includable under any of the above classifications. Finally, items of general interest to all fields of measurement and control, such as historical material, biographical, etc.

General (of interest to all in measurement or control fields) **(12.1)**
Miscellaneous (12.2)
Historical and Biographical (12.3)
Bibliographical (12.4)
Economic (12.5)

CONTROL FUNCTIONING EQUIPMENT (13)
Literature on the equipment used by operators or automatic controllers to perform their control functions will be covered under this heading. For example, the drum controller and associated switches, rheostats, relays, and motor starters by which an operator controls the motion of a crane are all pieces of "control functioning equipment."

Mechanical Control Functioning Equipment (13.1)
Electrical Control Functioning Equipment (13.2)
Includes drum controllers, relays, solenoids, etc.

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INSTRUMENTS EMPLOYMENT SERVICE

No charge for insertion of notices, which should be addressed to INSTRUMENTS Employment Service, 3619 Forbes Street, Pittsburgh, Pa., should be written tersely and must be received by the 25th of the month. In replying, put identification number on both envelope and letter.

MEN AVAILABLE

INSTRUMENT MAKER: 3½ years experimental laboratory of lamp company; 2 years experimental laboratory of electrical company. J-2.

PYROMETER MAN: Graduate Pennsylvania State College. Had charge of pyrometer calibration laboratory in plant with 1100 pyrometers. J-3.

ELECTRICAL ENGINEER: Graduate Charlottenburg Technische Hochschule; 8 years research engineer with chemical company; 4 years steel plant electrical engineer; can read German, French, Spanish and Italian. J-6.

INSTRUMENT SALESMAN: Mechanican Engineering Graduate; experienced sales and service most type of power plant instruments. District Sales Manager 5 years. Experience on gages, flow meter, CO_2 recorders, pyrometers and other testing equipment. J-8.

PYROMETER MAN: 8 years experience; expert electrician and gage (hydraulic, pressure, vacuum, etc.) service man; 3 years instrument laboratory; education equivalent two years of engineering college. J-9.

INSTRUMENT ENGINEER: Graduate Engineering College. Charge of instrument department in large industrial plant for 2½ years. J-10.

RADIO OPERATOR: Graduate Dodge Institute, 1917. Commercial license either broadcast or telegraph. J-12.

INSTRUMENT SALESMAN: Graduate M.E., 4 years control instruments, 2 years power plant specialties, 4 years manufacturing experience, in shop. Now N. Y. District Mgr. large rolling mill. J-13.

PHYSICIST: Ph.D. 1927. Experienced in electric and magnetic measurements, testing and research. J-14.

PRECISION INSTRUMENT MAKER: 28 years experience on scientific and geophysical instruments. J-15.

RADIO ENGINEER: Graduate University of Illinois; 2½ years experience in radio set circuit and tube measurements as well as development, design and patent investigation work. J-16.

ELECTRICAL METER and INSTRUMENT MAN: Technical graduate, 8 years in instrument laboratory of electrical manufacturing company. J-17.

INSTRUMENT ENGINEER: 2 years university, 5 years public utility, 2 years sales and service large recording and controlling instrument manufacturer. J-18.

INSTRUMENT MAKER: Engineering and Drafting instruments, 20 years shop experience, Master Degree Guild of Nuremburg. J-19.

ELECTRICAL ENGINEER: Graduate Purdue University. Experience with Telephone and Telegraph circuits, industrial control methods and equipment, and electrical instrument testing and maintenance. J-20.

AIRCRAFT INSTRUMENT MAINTENANCE ENGINEER: Formerly Service Engineer for largest manufacturer of aircraft instruments. Especially familiar with airplane instrument problems. J-21.

CHEMIST: Graduate Hunter College 1918. Spent twelve years working out various chemical processes in the laboratory and demonstrating them from a practical standpoint in paper mills. Work in the laboratory has included water analyses, some bacteriological work, fibre examination. and testing of various materials. J-22.

ADVERTISING MANAGER: Also assistant sales manager of flow meter manufacturing company. M.I.T. graduate Mechanical Engineer with 10 years shop, engineering, advertising and sales experience. J-23.

PHYSICIST: 2 years experience in research with particular training in atomics and electronics. Have held two fellowships. J-24.

COMMUNICATION ENGINEER: 10 years practical experience in installation, operation and maintenance of high frequency transmitters and receivers, also land line practice. Knowledge of Spanish. J-25.

ELECTRICAL ENGINEER: Experience with electric meter manufacturer and with an electrical testing laboratory. Master's degree in electrical engineering. J-26.

SALES ENGINEER: Sales promotion work on scientific instruments, industrial control, etc. Three years experience with manufacturer of scientific instruments and three years experience with manufacturer of automatic regulating devices. Graduate of University of Chicago. J-27.

ELECTRICAL ENGINEER: Graduate of University of Illinois with experience in development of control apparatus desires connection in research, design, or development of instruments or control apparatus. J-28.

SALES ENGINEER: B.S. degree, 1931, and graduate work in Physics and Chemistry, sales experience. Desires permanent connection with instrument manufacturer with opportunity to enter sales department. J-29.

MECHANICAL AND CHEMICAL ENGINEER: College graduate, experienced in general machine shop work, drafting. Three years as second assistant engineer in merchant marine. J-30.

SALES ENGINEER: Experienced in shop, service and sales. Interested in handling unit heat, ventilation and air conditioning apparatus. Licensed professional engineer. J-31.

METER SPECIALIST: 20 years experience with utilities and manufacturers. Meter, distribution and sales department. College education. J-32.

INSTRUMENT SALESMAN: Selling experience covers flow meters, CO_2 recorders; draft recorders and indicators; combustion and draft control; water and oil meters; electrical recording meters; watthour meters; testing devices and megohmers. J-33

RESEARCH ENGINEER: Technical Director, Chemical Engineer, Research Chemist, expert in paper, oils, dyes, chemicals, fuels, augment and improve production, cut costs, sales service, patents, literary work, 6 languages. Trained Harvard and abroad. J-34

MECHANICAL ENGINEER: 11 years experience in design, construction, sale, and servicing of power plant and industrial metering, regulating and control equipment. J-35

AUTOMATIC MACHINE DESIGNER: 15 years designing experience on automatic machines including 5 years, on boiler instruments, testing instruments and telegraph instruments. J-36

INSTRUMENT ENGINEER: B. S. degree 1925; four years with precision electrical instrument company in the research department. Specialized in resistance coil manufacture and constant temperature baths. J-37.

PURCHASING AGENT: Experienced in purchasing materials for instrument manufacturers. Can systematize and fully qualified to take complete charge of department. J-39.

MEASUREMENT AND CONTROL SPECIALIST: Seeks connection with commercial laboratory, public utility or manufacturer, in capacity of developing engineer or consultant. Wide and extensive experience with all types of electrical instruments, both American and foreign, precision measurement, standardization and automatic control. Wide experience in patent work. Also adept in pyrometry and pneumatic control. Member A. I. E. E. J-40.

ELECTRICAL ENGINEER: 32, 3 years electrical metering and automatic control; 5 years laboratory and practical measurement of gas flow, furnace temperatures and gas analysis. Some sales experience. J-41.

RESEARCH ENGINEER: Graduate electrochemical engineer. Three years experience in industrial research and instrument development, both electrical and electrochemical. Specialized in gas analysis equipment. Machine shop experience. Research or teaching preferred. J-42.

INSTRUMENT SALESMAN: College trained, 5½ years inside, 8 years selling specialized in control applications, etc., for pulp, paper, lumber, milk, canning, power and refrigeration. J-43.

SALES ENGINEER: 4 years experience recording and control instruments. Graduate engineer, sales or engineering work desirable U.S.A. or Canada. J-44.

ACOUSTICS & VIBRATIONS (6)

Sound, Vibration, Phenomena and Measurements (6.1)

Miniature Seismograph Measures Vibration. *Power*, Vol. 75, April 5, 1932, page 527.

A case containing a suspended block of lead is bolted to the machine under investigation. In the weight are embedded 2 coils on opposite sides. In front of each coil is an adjustable piece of magnetic steel, fastened to the outer shell. The coils are energized by 500-cycle a.c. and the air gaps between the coils and the magnetic steel adjusted so that the 2 coils are electrically balanced. Vibration varies the distance between the coils and the magnetic pieces, causing a variation in the flow of current which is indicated or recorded in amplitudes of vibration. AHE (6.1)

New Vibration-Voltage Converters. BRUSH DEVELOPMENT CO. *Instruments*, Vol. 5, June 1932, page 163.

Description, 2 photos of device comprising a piezo-electric microphone and a loud-speaker motor. Frequency range 10 to 10,000 cycles. Vibrations converted to voltage or vice versa. MFB (6.1)

Method for Investigating the Vibration of Membranes, Particularly Those of Loud-Speakers. (Eine Methode zur Untersuchung der Schwingungen von Membranen, im besonderen von Lautsprechermembranen.) B. VOIGT. *Zeitschrift fuer technische Physik*, Vol. 12, Feb. 1931, pages 76-85.

Applies the stroboscopic method to render the vibrations visible. EF (6.1)

The Rayleigh Disc Used as a Ballistic Instrument. (Rayleighsche Scheibe als Ballistisches Geraet.) L. FREIMANN & I. RUSSAKOW. *Zeitschrift fuer technische Physik*, Vol. 12, Feb. 1931, pages 125-126.

The Rayleigh disk can be employed for pulsating sound measurements as well as for steady ones. EF (6.1)

A Balance Method of Measuring Sound Transmission. A. E. KNOWLER, *London, Edinburgh and Dublin Philosophical Magazine, and Journal of Science*, Ser. 7, Vol. 12, Nov. 1931, pages 1039-1042.

A study of sound transmission through partitions. A loud speaker is placed in each of two rooms. An observer is in one room and the speaker is in series with a variable shunt, this is adjusted till the volume is apparently the same. This is checked by the observation being made in the other room with the other speaker. A double fibre board (No. 4) wall has a greater reduction factor than a 4½ inch brick wall. RHP (6.1)

The Theory and Performance of Certain Types of Modern Acoustic Apparatus for Reproducing Speech and Music. N. W. MCLACHLAN & G. A. V. SOWTER. *Philosophical Magazine and Journal of Science*, Series 7, Vol. 11, Jan. 1931, pages 1-54.

The present paper has as its objects to compare the theory and practical results of coil-and-reed-driven rigid disks as applied to the reproduction of sound. It is shown that both coil-and-reed-driven disks, where the whole moving system is quite rigid, would be of little value in the reproduction of speech and music. In practice, conical and reed-driven diaphragms give better results than those to be expected from the rigid disk theory. This is due mainly in the coil case to the elasticity of the general structure. The radial velocity of sound has been measured in aluminum and steel disks, also near the periphery of a conical diaphragm; in the latter case it is considerable less than that of sound in air. The reproduction of transients by a coil-driven rigid disk system is analyzed and the results compared with those obtained experimentally from coil-and-reed-driven systems. The electrical, mechanical, and accoustical causes of distortion in a coil-driven reproducer are investigated and tables of various functions used in the calculations of data for design purposes are given in an appendix. Ha (6.1)

A New Principle of Sound Frequency Analysis. THEODORE THEODORSEN. *National Advisory Committee for Aeronautics*, Report No. 395, 1931, 15 pages.

An automatic recording instrument is described in detail. It employs a beat-frequency oscillator as a source of variable frequency. A large number of experiments have verified the predicted superiority of the method. A number of representative records are presented. Ha (6.1)

Quartz Crystal Resonators. W. A. MARRISON. *Bell Laboratories Record*, Vol. 10, Feb. 1932, pages 194-199.

The nature of piezo-electric effects is explained and shown how quartz crystals which are the most suitable for this action can be cut according to certain axes to set up vibrations of definite character. The greatest use of this property of quartz crystals is made in the control of frequency in radio transmitters and as frequency standards; the frequencies produced can range from as low as 1000 cycles to more than 100,000 cycles. Ha (6.1)

Experimental and Theoretical Study of Critical Vibrations of Motor Crankshafts. M. ANDREAU. *Journal de la Société des Ingénieurs de l'Automobile*, Nov. 1931, page 1530.

In attacking the subject of critical speeds, the author started with fundamentals and considered only the primary factors. His object was simplification and obtaining of results that could be applied in practice. The errors due to such simplification are claimed to be small and to be responsible for less misapprehension than the specious exactitude of more complex calculations.

A summary of the principles of vibrating bodies in general is first given. What light the classical theory throws on crankshaft vibration and what elements of the theory are of particular importance in this connection are then pointed out. Next, the conditions peculiar to crankshafts are discussed and the experimental method used by the author is described and illustrated with values obtained for several engines. Finally, an analytical method is presented which is said to make possible the determination, in any given case, of the modifications necessary to remove the critical speed from the range of operation. (6.1)

LIGHT, OPTICS, & RAYS (7)

Light—General Measurements and Optical Applications (7.1)

Diffraction Phenomena and Their Measurement (Die Beugenzserscheiuungen und iIive Messung). BODO VOIGT. *Archiv Technisches Messen*, Vol. 1, Feb. 23, 1932, section V 47-3, pages T8-9.

Explains diffraction and discusses its use in spectroscopy. The distribution of intensity in various diffraction pictures is analyzed and it is shown how this can be used for the determination of the wave-length of the light. Different diffraction gratings of Rowland, Michelson, etc., are described. Ha (7.1)

Light and the Human Machine. M. LUCKIESH. *Electrical World*, Vol. 98, Dec. 5, 1931, page 1001.

The new science of "lighting for seeing" must include a consideration of cost in eyesight and well-being of workers as well as economic phases of lighting, such as increased production and cost of lighting. A study of some of the physiological effects of a day's work has been made and certain facts ascertained which are readily associated with the influence of lighting. Eyes of subjects were tested at the beginning and again at the close of the day's work. In addition, subjects were required to perform mechanical and visual tasks and rates of working accuracy and attentiveness to the work were determined. (7.1)

Hot Cathode Sodium Vapor Lamp. WESTINGHOUSE ELECTRIC AND MFG. CO. *Instruments*, Vol. 5, May 1932, pages 124-125.

Brief illustrated description of new glow lamp said to be the most efficient light source ever developed. MFB (7.1)

Interference Measurement in Transmitted and Reflected Light. (Interferenzmessung im durchgehenden und reflektierten Licht.) BODO VOIGHT. *Archiv für Technisches Messen*, Vol. 1, 1931, section V47-2, pages T70-71.

Interference phenomena are used in measurements of spectroscopy, polarization, testing of evenness of a surface, photometry, ultra-microscopy, heat expansion, etc. The various methods of measuring the wave-length; by the Fresnel mirror method; Haidlinger's interference curves; Herschel's stripes, interference spectroscope of Lummer and Gehrcke, Brewster, the interferential refractor, Lummer's stripes, and Michelson's interferometer for the evaluation of the meter in wave-lengths are described and the mathematical foundations explained. 8 references. Ha (7.1)

Laboratory for Precision Linear Measurements. E. C. ERICKSON. *Bell Laboratories Record*, Vol. 10, March 1932, pages 255-260.

Describes the measuring equipment and methods for insuring interchangeability without individual fitting of the large numbers of telephone parts. The micro-interferometer for checking gages to 0.00001 in. is described. Ha (7.1)

New Knowledge of Old Telescopes. (A supplement to the third paper on the Court collection.) THOMAS H. COURT & MORITZ VON ROHR. *Transactions of the Optical Society*. Vol. 32, 1930-31, pages 113-122.

Three documents referring to the development of the telescope are discussed. They are arranged with respect to the gradual development of this optical device and its production in London. Document I is a letter written by Beal on 24th November, 1656. It refers only to the Dutch or Galilean telescope and gives interesting details regarding the hand-glass used by Gustavus Adolphus and the taste shown by the English opticians of 1656 in decorating the bodies of Galilean telean telescopes. Document II is a photographic reproduction of J. Wiesel's price list of 1647. It is by far the most important from the historical standpoint. From it we learn some details of the industrial development of Wiesel's telescope factory in Augsburg at the surprisingly early date of 1647. Document III is a letter written by the well-known London optician Richard Reeves on 11th March, 1660. It informs us of the state of telescope manufacture in London at that time. The prices given for the three kinds of telescopes—Dutch or Galilean, Keplerian, and Schyrlean—are quite reasonable and much lower than those quoted in Document II. (7.1)

Simple Illuminometer. WESTON ELECTRICAL INSTRUMENT CORP. *Instruments*, Vol. 5, Jan. 1932, page 22; *Power*, Vol. 75, Jan. 19, 1932, page 112.

It consists of an indicating instrument and a light target assembled in a portable case. This light target or searching unit has 2 Photronic Cell units which convert light energy directly into electrical energy. The output from the Photronic Cell units is considerable, allowing the use of a rugged portable instrument calibrated directly in foot-candles. HO (7.1)

The Application of Reflected Light to the Microscopic Examination of Leather. A. KUNTZEL. *The Instrument World*, Vol. 4, Jan. 1932, pages 167-172.

The article explains the more and more increasing use of the microscope in the preparation of leather from the skins of animals for the detection of manufacturing faults or traces of damage to the raw hide. The various optical methods and instruments for the use of reflected light are described and illustrations of tanned and colored specimens reproduced. Ha (7.1)

New Telescope. BAUSCH & LOMB OPTICAL COMPANY. *Instruments*, Vol. 5, Feb. 1932, page 60.

Four eyepieces are provided with this new telescope giving wide range of magnifying power. HO (7.1)

Plenary Session of the International Commission on Illumination. (Session Plénière de la Commission internationale de l'Éclairage.) MAURICE LEBLANC. *Revue Générale de l'Électricité*, Jan. 16, 1932, pages 67-75.

Report of the meeting which was held in Cambridge, England, Sept. 13-19, 1931. Includes summaries of committee reports on standard white light based on the properties of a black body; definitions and symbols; heterochromatic photometry; photometric test plates; accuracy of photometry; and colorimetry. MS (7.1)

The Emmons Double Variation Apparatus. *Instrument World*, Vol. 4, Feb. 1932, pages 187-188, 196.

The instrument measures the refractive index of crystals by the Becke line method in conjunction with monochromatic illumination and accurate temperature control and for the principal directions of the crystal. The apparatus and method of operation are described. Ha (7.1)

CHEMISTRY (8)

Modern Instruments for the Needs of Chemical Industry. *Chemical Age*, Vol. 26, Jan. 9, 1932, pages 28-29.
A brief review of new instruments, laboratory equipment, vacuum apparatus, rate of flow control, etc., at Joint Exhibition of (British) Physical and Optical Societies. VVK (8)

An Automatic Recorder for Sulphur Acids in Flue Gases. J. J. Fox & L. G. Groves. *Journal Society Chemical Industry*, Vol. 51, Jan. 8, 1932, pages 7-10T.
Method consists in the automatic absorption by scrubbing of a continuous stream of flue gas with a dilute solution of H_2O_2 whereby SO_2 is oxidized to H_2SO_4; determination of the altered pH by means of a glass electrode; amplification of the changing voltage by means of vacuum tubes; and finally recording voltage on a chart. Since concentration of SO_2 remaining after adequate purification of flue gas is small, the recorder measures from 0 to 150 p.p.m. SO_2 in flue gas. VVK (8)

Automatic Recorder for Condenser Leakage. *Power*, Vol. 74, Dec. 29, 1931, page 949; Vol. 75, Feb. 23, 1932, page 280.
Three conductivity cells measure the conductance in the hot well, in the distillate or condensed steam taken from the turbine with no opportunity for condenser leakage, and in an artificially prepared mixture of distillate and cooling water. AHE (8)

Indicating and Recording Flue-Gas Analyzer. *Steam-Plant Engineering*, Vol. 1, No. 3, March 1932, page 50.
An instrument for indicating and recording CO_2 and unburned gases (Co and H_2) is described. AHE (8)

Instrument for Colorimetric pH Control. *Power*, Vol. 73, March 24, 1931, page 493, Vol. 75, Feb. 23, 1932, page 284.
Description of a slide comparator. AHE (8)

Comparator Employs Colored Glass Standards. *Power*, Vol. 73, Apr. 28, 1931, page 679; Vol. 75, Feb. 23, 1932, page 284.
Substitution of colored glass for colored solutions in a comparator for boiler H_2O treatment control is described. AHE (8)

Chemical Feeds for Water-Treating System. *Power*, Vol. 73, Apr. 28, 1931, page 680; Vol. 75, Feb. 23, 1932, page 286.
Two types of automatic chemical feeds for H_2O-treating systems are described and illustrated. AHE (8)

New Chlorine Comparator. *Power*, Vol. 74, Nov. 3, 1931, page 654; Vol. 75, Feb. 23, 1932, page 284.
A comparator for determination of Cl colorimetrically is described. AHE (8)

Testing Instrument for Calcium Chloride Brine. *Power*, Vol. 74, July 14, 1931, page 66; Vol. 75, Feb. 23, 1932, page 285.
The calci-chlor-o-meter shows automatically the exact freezing point of any $CaCl_2$ brine, taking into consideration the temperature of the brine. AHE (8)

Combustible Gas Indicator. Mine Safety Appliances Co. *Instruments*, Vol. 5, June 1932, page 162.
Description, 1 photo., 1 diagram, of new portable, self-contained, direct-reading instrument which employs platinum filaments for catalytic burning of combustible content of sample. MFB (8)

Interpretation of Water Analysis Simplified by Table. Norman C. Wittmer. *Water Works Engineering*, Vol. 85, April 20, 1932, pages 436-438.
Concise tabulation of common tests applied to water analysis with their significance, the practical standards, and methods of treatment. CBJ (8)

Potentiometric Determination of Saponification Number of Mixtures of Asphalt and Drying Oils. James V. Demarest and Wm. Rieman, 3rd. *Industrial Engineering Chemistry, Analytical Edition*, Vol. 3, Jan. 15, 1931, pages 15-17.
The saponification number of linseed oil and asphalt, separately or mixed, can be determined potentiometrically with high precision and with no more expenditure of time than is required in other methods. Curves are given. MEH (8)

Spectrographic Determination of Aluminum in Biological Ashes. Dee Tourtellotte and O. S. Rask. *Industrial Engineering Chemistry, Analytical Edition*, Vol. 3, Jan. 15, 1931, pages 97-102.
Modifications are developed of the spectrographic method of quantitative analysis involving both arc and condensed spark methods of excitation. MEH (8)

The Density and Surface Tension of the Isomers of 2-pentene and 2-methyl-2-butene. W. F. Seyer. *Journal American Chemical Society*, Vol. 53, Oct. 1931, page 5388.
These properties have been measured over a range of temperatures of 150°. (8)

Hydrogen-Ion Determinations with Low-Resistance Glass Electrodes. G. Ross Robertson. *Industrial Engineering Chemistry, Analytical Edition*, Vol. 3, Jan. 15, 1931, pages 5-7.
A description is given of glass electrodes which have resistances of but 2 to 3 megohms, and are made of commercially available glass. Such electrodes permit the use of a d'Arsonval galvanometer in pH estimation with fair accuracy. Their use requires little more skill than is needed with an industrial quinhydrone apparatus. MEH (8)

Determination of Sulfur by Means of the Turbidimeter. S. W. Parr and W. D. Staley. *Industrial Engineering Chemistry, Analytical Edition*, Vol. 3, Jan. 15, 1931, pages 66-67.
Presented before the Division of Gas and Fuel Chemistry at the Cincinnati meeting of the American Chemical Society, Sept. 1930. The new design of turbidimeter gives a sharp end point and a good agreement in the results obtained. MEH (8)

A Laboratory Apparatus for the Continuous Extraction of Liquids by Low-Boiling Solvents. R. T. Leslie. *Bureau of Standards Journal of Research*, Vol. 8, May 1932, pages 591-599.
Described apparatus is counter-current and continuous in operation. Details of construction. Method of operation. Brief discussion of the performance of the apparatus for the extraction of petroleum fractions with liquid sulphur dioxide. WAT (8)

CONTROL FUNCTIONING EQUIPMENT (13)

Electrical Control Functioning Equipment (13.2)

Protective Distance Relay. Westinghouse Elec. & Mfg. Co. *Instruments*, Vol. 5, Feb. 1932, page 58.
This new relay was developed for application on the shorter line sections where the arc resistance may reach a value comparable to the line impedance.
The principle employed is particularly valuable in that it imparts a wide flexibility to the distance measuring characteristic. HO (13.2)

Vacuum Contact Toggle Switch. Burgess Battery Company. *Instruments*, Vol. 5, Feb. 1932, page 53.
In this new toggle switch the throwing of the handle to the closed position serves to actuate the external glass stem of the vacuum contact, either making or breaking the circuit as desired. HO (13.2)

Pole-Changing Speed-Control Switch. General Electric Company. *Instruments*, Vol. 5, Feb. 1932, page 53.
These switches are for obtaining different speeds by changing the polar grouping of the stator coils of squirrel-cage induction motors.
In operation the speed point is selected by turning the knob handle to the desired position. HO (13.2)

Explosion Proof A. C. Automatic Starter. Cutler-Hammer, Inc. *Instruments*, Vol. 5, Feb. 1932, page 53.
This new starter is of the air-break type. The heavy cast-iron, explosion proof, enclosure is designed to prevent any explosion which might occur within it from igniting the surrounding explosive atmosphere. HO (13.2)

Solving Electric Control Problems by the Application of Standard Accessories. F. L. Spangler. *Machine Design*, Vol. 3, Dec. 1931, pages 32-36, 58.
Push buttons, switches, etc. with safety arrangements against wrong use and manual or automatic operation are described in their various applications. Ha (13.2)

New Motor Controllers. *Electrical Review*, Jan. 15, 1932, page 83.
Description of an improved range of contactor-break a.c. gear, incorporating short-circuit fuses and thermal overload trips, developed by Brookhirst Switchgear, Ltd. Cartridge fuses have a rupturing capacity of 25,000 kva at 440 volts. A tell-tale indicator shows when an element has fused. Fuses are arranged to operate under short-circuit conditions independently of the main contactor on the motor control panel. Overload trips function on a time-temperature basis. The heating elements are wire wound and independent of the bimetal strips which bend upwards as the current increases and cause the overload trip switch to open. The circuit making and breaking is carried out by a triple-pole electrically-operated contactor. Contacts are of the rolling butt type. MS (13.2)

A. C. Protective Relays. C. W. Lipman. *Electrical Review*, Jan. 15, 1932, page 85.
Abstract of paper read before the Institution of Electrical Engineers, Jan. 8, 1932. Describes some recent advances in design. Formulates the requirements of an "ideal" protective relay. Several described in the paper approach very closely to the ideal. One of these is a differential relay in which the electromagnet is provided with an auxiliary core magnetically in parallel with the main core. The moving system is essentially of the double-rotor type and consists of a main rotor and an auxiliary rotor, both of aluminum, secured to a common spindle which carries also the control spring and the moving contact. The auxiliary core is provided with a suitable air-gap within which the auxiliary rotor is free to move. Author has devised a time-selective relay. The essential feature is that the space disposition of the inner core of the electromagnet, generally of cruciform shape, can be varied in any desired manner during the operation of the relay by means of an external driving, or timing, device, such as clock-work mechanism or its equivalent. The working principle is the converse of the basic idea of relay construction. MS (13.2)

Rectox Simplifies Breaker Control. *Electrical West*, Jan. 1, 1932, page 8.
At the Antioch substation of the Pacific Gas and Electric Co. large oil circuit breakers are closed by solenoid mechanisms, operated by a Rectox rectifier rated 220 volts a.c., 60 cycles, 125 volts d.c. The rectifier is assembled from copper oxid washers. MS (13.2)

Domestic Apparatus Control. *Electrical Review*, Dec. 18, 1931, page 914.
Describes the "Birka" regulator known as the "vacuum wire-type thermal relay." Bimetal used in earlier designs has been replaced by resistance wires directly heated by the relay current which causes them to expand, opening or closing the main contacts. The wires are arranged mechanically in parallel and electrically in series. Diameter of wires is 0.3 mm. Current may exceed 60 amp. at voltages up to 1000 a.c. or d.c., as in a high vacuum a circuit can be broken without arcing by separating the contacts by less than 1×10^{-3} mm., and the contact pressure required is very slight. Relay current ranges between 30 and 70 milliamps, while the time and temperature lag can be adjusted from ½ sec. and 1°C. upwards. Every relay is guaranteed for 200,000 makes and breaks. MS (13.2)

Remote Control of Voltage Regulators of Plating Baths. (Fernsteuerung von Spannungsreglern galvanischer Bäder.) Huetter. *Oberflächentechnik*, Vol. 9, Feb. 16, 1932, page 33.
The voltage of the galvanizing dynamo can be regulated by a magnetic regulator on the machine which is operated by a push-button on each bath so that a change in voltage due to change in load can be compensated directly. Ha (13.2)

Across-the-Line Motor Switch with Low-Voltage Control. *Power*, Vol. 75, Feb. 2, 1932, page 183.
Alternating-current, across-the-line, motor-starting switches (Allen-Bradley) are now available with a step-down control transformer for reducing the control-circuit voltage to 110 volts when the switch is used on 440- or 550-volt circuits. AHE (13.2)

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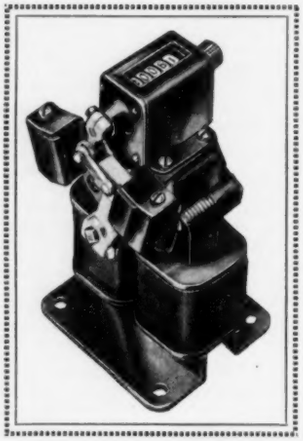

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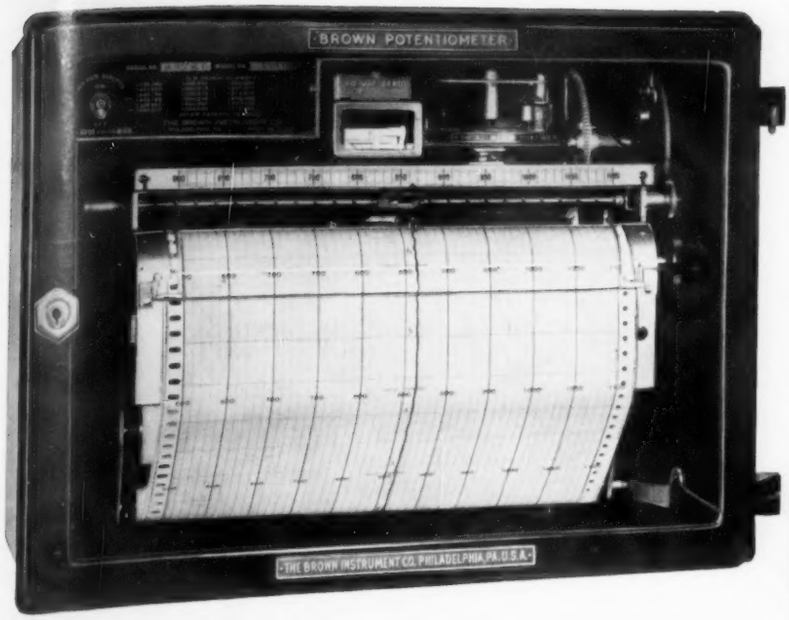

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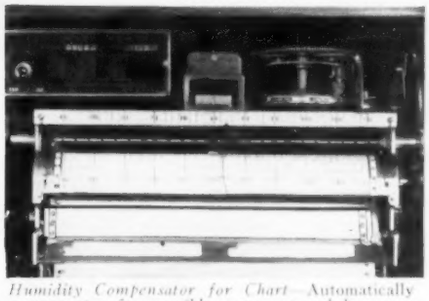

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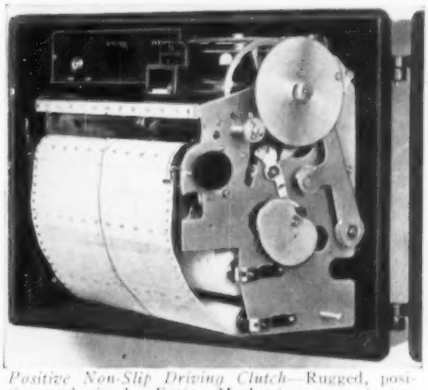

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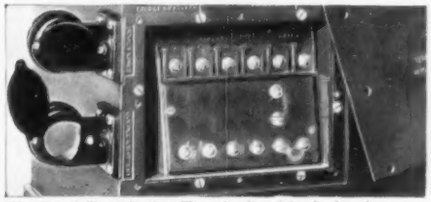

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